



US008633178B2

(12) **United States Patent**
Bernick et al.

(10) **Patent No.:** **US 8,633,178 B2**
(45) **Date of Patent:** **Jan. 21, 2014**

(54) **NATURAL COMBINATION HORMONE
REPLACEMENT FORMULATIONS AND
THERAPIES**

(71) Applicant: **TherapeuticsMD, Inc.**, Boca Raton, FL
(US)

(72) Inventors: **Brian A. Bernick**, Boca Raton, FL (US);
Janice Louise Cacace, Miami, FL (US);
Peter H. R. Persicaner, Boca Raton, FL
(US); **Neda Irani**, Palm Beach Garden,
FL (US); **Julia M. Amadio**, Boca Raton,
FL (US)

(73) Assignee: **TherapeuticsMD, Inc.**, Boca Raton, FL
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/684,002**

(22) Filed: **Nov. 21, 2012**

(65) **Prior Publication Data**

US 2013/0129818 A1 May 23, 2013

Related U.S. Application Data

(60) Provisional application No. 61/563,408, filed on Nov.
23, 2011, provisional application No. 61/661,302,
filed on Jun. 18, 2012, provisional application No.
61/662,265, filed on Jun. 20, 2012.

(51) **Int. Cl.**
A01N 45/00 (2006.01)
A61K 9/48 (2006.01)

(52) **U.S. Cl.**
USPC **514/169; 424/452**

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,967,351 A 7/1934 Dolay
2,232,438 A 2/1941 Butenandt
2,379,832 A 7/1945 Serini et al.
2,649,399 A 8/1953 Beall et al.
3,198,707 A 8/1965 Nomine et al.
3,478,070 A 11/1969 Stein et al.
3,526,648 A 9/1970 Bertin et al.
3,710,795 A 1/1973 Higuchi et al.
3,729,560 A 4/1973 Hagerman
3,729,566 A 4/1973 Ericsson et al.
3,755,573 A 8/1973 Berman
3,755,575 A 8/1973 Lerner
3,903,880 A 9/1975 Higuchi et al.
3,916,898 A 11/1975 Robinson
3,916,899 A 11/1975 Theeuwes et al.
3,921,636 A 11/1975 Zaffaroni
3,923,997 A 12/1975 Meuly
3,948,254 A 4/1976 Zaffaroni
3,971,367 A 7/1976 Zaffaroni
3,977,404 A 8/1976 Theeuwes

3,993,072 A 11/1976 Zaffaroni
4,008,719 A 2/1977 Theeuwes et al.
4,012,496 A 3/1977 Schopflin et al.
4,014,334 A 3/1977 Theeuwes et al.
4,014,987 A 3/1977 Heller et al.
4,016,251 A 4/1977 Higuchi et al.
4,071,623 A 1/1978 van der Vies
4,093,709 A 6/1978 Choi et al.
4,154,820 A 5/1979 Simoons
4,155,991 A 5/1979 Schopflin et al.
4,196,188 A 4/1980 Besins
4,215,691 A 8/1980 Wong
4,237,885 A 12/1980 Wong et al.
4,310,510 A 1/1982 Sherman et al.
4,327,725 A 5/1982 Cortese et al.
4,372,951 A 2/1983 Vorys
4,393,871 A 7/1983 Vorhauer et al.
4,402,695 A 9/1983 Wong
4,423,151 A 12/1983 Baranczuk
4,449,980 A 5/1984 Millar et al.
4,610,687 A 9/1986 Fogwell
4,629,449 A 12/1986 Wong
4,732,763 A 3/1988 Beck et al.
4,738,957 A 4/1988 Laurent et al.
4,756,907 A 7/1988 Beck et al.
4,762,717 A 8/1988 Crowley, Jr.
4,788,062 A 11/1988 Gale et al.
4,816,257 A 3/1989 Buster et al.
4,822,616 A 4/1989 Zimmermann et al.
4,865,848 A 9/1989 Cheng et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 102258455 11/2011
EP 0275716 A1 7/1988
EP 0622075 A1 11/1994
EP 0785211 A1 1/1996
EP 0785212 A1 1/1996
EP 0811381 A1 6/1997
EP 2191833 A1 6/2010
GB 720561 12/1954
GB 848881 A1 9/1960
GB 874368 8/1961

(Continued)

OTHER PUBLICATIONS

Azeem et al., "Microemulsions as a Surrogate Carrier for Dermal
Drug Delivery," Drug Development and Industrial Pharmacy,
35(5):525-547. 2009. Abstract Only.

(Continued)

Primary Examiner — Frederick Krass

Assistant Examiner — Dennis J Parad

(74) *Attorney, Agent, or Firm* — Marlan D. Walker; Snell &
Wilmer LLP

(57) **ABSTRACT**

Estrogen and progesterone replacement therapies are pro-
vided herein. Among others, the following formulations are
provided herein: solubilized estradiol without progesterone;
micronized progesterone without estradiol; micronized
progesterone with partially solubilized progesterone; solubi-
lized estradiol with micronized progesterone; solubilized
estradiol with micronized progesterone in combination with
partially solubilized progesterone; and solubilized estradiol
with solubilized progesterone.

6 Claims, 4 Drawing Sheets

(56)

References Cited

U.S. PATENT DOCUMENTS

| | | | | | | | |
|-----------|-----|---------|----------------------------|-----------|----|---------|--------------------|
| 4,900,734 | A * | 2/1990 | Maxson et al. 514/171 | 6,039,968 | A | 3/2000 | Nabahi |
| 4,906,475 | A | 3/1990 | Kim | 6,056,972 | A | 5/2000 | Hermismeyer |
| 4,942,158 | A | 7/1990 | Sarpotdar et al. | 6,060,077 | A | 5/2000 | Meignant |
| 4,961,931 | A | 10/1990 | Wong | 6,074,625 | A | 6/2000 | Hawthorne et al. |
| 5,030,629 | A | 7/1991 | Rajadhyaksha | 6,077,531 | A | 6/2000 | Salin-Drouin |
| 5,064,654 | A | 11/1991 | Berner et al. | 6,080,118 | A | 6/2000 | Blythe |
| 5,108,995 | A | 4/1992 | Casper | 6,083,178 | A | 7/2000 | Caillouette |
| 5,128,138 | A | 7/1992 | Blank | 6,086,916 | A | 7/2000 | Agnus et al. |
| 5,130,137 | A | 7/1992 | Crowley, Jr. | 6,096,338 | A | 8/2000 | Lacy et al. |
| 5,140,021 | A | 8/1992 | Maxson et al. | 6,117,446 | A | 9/2000 | Place |
| 5,211,952 | A | 5/1993 | Spicer et al. | 6,117,450 | A | 9/2000 | Dittgen et al. |
| 5,252,334 | A | 10/1993 | Chiang et al. | 6,133,251 | A | 10/2000 | Dittgen et al. |
| 5,280,023 | A | 1/1994 | Ehrlich et al. | 6,133,320 | A | 10/2000 | Yallampalli et al. |
| 5,288,496 | A | 2/1994 | Lewis | 6,139,873 | A | 10/2000 | Hughes, Jr. et al. |
| 5,340,584 | A | 8/1994 | Spicer et al. | 6,153,216 | A | 11/2000 | Cordes et al. |
| 5,340,585 | A | 8/1994 | Pike et al. | 6,165,491 | A | 12/2000 | Grasset et al. |
| 5,340,586 | A | 8/1994 | Pike et al. | 6,165,975 | A | 12/2000 | Adams et al. |
| 5,362,497 | A | 11/1994 | Yamada et al. | 6,187,339 | B1 | 2/2001 | de Haan et al. |
| 5,382,573 | A | 1/1995 | Casper | 6,190,331 | B1 | 2/2001 | Caillouette |
| 5,393,528 | A | 2/1995 | Staab | 6,201,072 | B1 | 3/2001 | Rathi et al. |
| 5,393,529 | A | 2/1995 | Hoffmann et al. | 6,227,202 | B1 | 5/2001 | Matapurkar |
| 5,419,910 | A | 5/1995 | Lewis | 6,262,115 | B1 | 7/2001 | Guittard et al. |
| 5,468,736 | A | 11/1995 | Hodgen | 6,277,418 | B1 | 8/2001 | Markaverich et al. |
| 5,474,783 | A | 12/1995 | Miranda et al. | 6,283,927 | B1 | 9/2001 | Caillouette |
| 5,480,776 | A | 1/1996 | Dullien | 6,287,588 | B1 | 9/2001 | Shih et al. |
| 5,514,673 | A | 5/1996 | Heckenmuller et al. | 6,287,693 | B1 | 9/2001 | Savoir et al. |
| 5,516,528 | A | 5/1996 | Hughes et al. | 6,294,188 | B1 | 9/2001 | Ragavan et al. |
| 5,527,534 | A | 6/1996 | Myhling | 6,294,550 | B1 | 9/2001 | Place et al. |
| 5,529,782 | A | 6/1996 | Staab | 6,299,900 | B1 | 10/2001 | Reed et al. |
| 5,543,150 | A | 8/1996 | Bologna et al. | 6,306,841 | B1 | 10/2001 | Place et al. |
| 5,547,948 | A | 8/1996 | Barcomb | 6,306,914 | B1 | 10/2001 | de Ziegler et al. |
| 5,565,199 | A | 10/1996 | Page et al. | 6,309,669 | B1 | 10/2001 | Setterstrom et al. |
| 5,567,831 | A | 10/1996 | Li | 6,309,848 | B1 | 10/2001 | Howett et al. |
| 5,569,652 | A | 10/1996 | Beier et al. | 6,342,491 | B1 | 1/2002 | Dey et al. |
| 5,582,592 | A | 12/1996 | Kendrick | 6,372,209 | B1 | 4/2002 | Chrisope |
| 5,585,370 | A | 12/1996 | Casper | 6,372,246 | B1 | 4/2002 | Wei et al. |
| 5,595,759 | A | 1/1997 | Wright et al. | 6,387,390 | B1 | 5/2002 | Deaver et al. |
| 5,595,970 | A | 1/1997 | Garfield et al. | 6,402,705 | B1 | 6/2002 | Caillouette |
| 5,620,705 | A | 4/1997 | Dong et al. | 6,416,778 | B1 | 7/2002 | Ragavan et al. |
| 5,629,021 | A | 5/1997 | Wright | 6,423,039 | B1 | 7/2002 | Rathbone et al. |
| 5,633,011 | A | 5/1997 | Dong et al. | 6,423,683 | B1 | 7/2002 | Heaton et al. |
| 5,633,242 | A | 5/1997 | Oettel et al. | 6,436,633 | B1 | 8/2002 | Kreider et al. |
| 5,639,743 | A | 6/1997 | Kaswan et al. | 6,440,454 | B1 | 8/2002 | Santoro et al. |
| 5,656,286 | A | 8/1997 | Miranda et al. | 6,444,224 | B1 | 9/2002 | Rathbone et al. |
| 5,676,968 | A | 10/1997 | Lipp et al. | 6,451,339 | B2 | 9/2002 | Patel et al. |
| 5,677,292 | A | 10/1997 | Li et al. | 6,451,779 | B1 | 9/2002 | Hesch |
| 5,694,947 | A | 12/1997 | Lehtinen et al. | 6,455,246 | B1 | 9/2002 | Howett et al. |
| 5,709,844 | A | 1/1998 | Arbeit et al. | 6,455,517 | B1 | 9/2002 | Tanabe et al. |
| 5,735,801 | A | 4/1998 | Caillouette | 6,468,526 | B2 | 10/2002 | Chrisope |
| 5,739,176 | A | 4/1998 | Dunn et al. | 6,469,016 | B1 | 10/2002 | Place et al. |
| 5,744,463 | A | 4/1998 | Bair | 6,472,434 | B1 | 10/2002 | Place et al. |
| 5,747,058 | A | 5/1998 | Tipton et al. | 6,479,232 | B1 | 11/2002 | Howett et al. |
| 5,770,219 | A | 6/1998 | Chiang et al. | 6,500,814 | B1 | 12/2002 | Hesch |
| 5,776,495 | A | 7/1998 | Duclos et al. | 6,503,896 | B1 | 1/2003 | Tanabe et al. |
| 5,788,980 | A | 8/1998 | Nabahi | 6,526,980 | B1 | 3/2003 | Tracy et al. |
| 5,789,442 | A | 8/1998 | Garfield et al. | 6,528,094 | B1 | 3/2003 | Savoir et al. |
| 5,811,416 | A | 9/1998 | Chwalisz et al. | 6,537,580 | B1 | 3/2003 | Savoir et al. |
| 5,814,329 | A | 9/1998 | Shah | 6,544,196 | B2 | 4/2003 | Caillouette |
| 5,827,200 | A | 10/1998 | Caillouette | 6,544,553 | B1 | 4/2003 | Hsia et al. |
| 5,866,603 | A | 2/1999 | Li et al. | 6,548,491 | B2 | 4/2003 | Tanabe et al. |
| 5,891,868 | A | 4/1999 | Cummings et al. | 6,551,611 | B2 | 4/2003 | Elliesen et al. |
| 5,898,038 | A | 4/1999 | Yallampalli et al. | 6,569,463 | B2 | 5/2003 | Patel et al. |
| 5,916,176 | A | 6/1999 | Caillouette | 6,583,129 | B1 | 6/2003 | Mazer et al. |
| RE36,247 | E | 7/1999 | Plunkett et al. | 6,586,006 | B2 | 7/2003 | Roser et al. |
| 5,922,349 | A | 7/1999 | Elliesen et al. | 6,589,549 | B2 | 7/2003 | Shih et al. |
| 5,928,666 | A | 7/1999 | Farinas et al. | 6,593,317 | B1 | 7/2003 | de Ziegler et al. |
| 5,958,446 | A | 9/1999 | Miranda et al. | 6,610,652 | B2 | 8/2003 | Adams et al. |
| 5,962,445 | A | 10/1999 | Stewart | 6,610,670 | B2 | 8/2003 | Backensfeld et al. |
| 5,972,372 | A | 10/1999 | Saleh et al. | 6,638,536 | B2 | 10/2003 | Savoir et al. |
| 5,985,861 | A | 11/1999 | Levine et al. | 6,645,528 | B1 | 11/2003 | Straub et al. |
| 5,993,856 | A | 11/1999 | Ragavan et al. | 6,653,298 | B2 | 11/2003 | Potter et al. |
| 6,001,846 | A | 12/1999 | Edwards et al. | 6,656,929 | B1 | 12/2003 | Agnus et al. |
| 6,022,562 | A | 2/2000 | Autant et al. | 6,660,726 | B2 | 12/2003 | Hill et al. |
| 6,024,976 | A | 2/2000 | Miranda et al. | 6,663,608 | B2 | 12/2003 | Rathbone et al. |
| 6,028,057 | A | 2/2000 | Burns | 6,663,895 | B2 | 12/2003 | Savoir et al. |
| | | | | 6,692,763 | B1 | 2/2004 | Cummings et al. |
| | | | | 6,737,081 | B2 | 5/2004 | Savoir et al. |
| | | | | 6,740,333 | B2 | 5/2004 | Beckett et al. |
| | | | | 6,743,815 | B2 | 6/2004 | Huebner et al. |

(56)

References Cited

U.S. PATENT DOCUMENTS

- | | | | | | | | |
|-----------|----|---------|---------------------|--------------|-----|---------|--------------------------|
| 6,747,018 | B2 | 6/2004 | Tanabe et al. | 7,727,720 | B2 | 6/2010 | Dhallan |
| 6,756,208 | B2 | 6/2004 | Griffin et al. | 7,732,408 | B2 | 6/2010 | Josephson et al. |
| 6,776,164 | B2 | 8/2004 | Bunt et al. | 7,749,989 | B2 | 7/2010 | Hill et al. |
| 6,805,877 | B2 | 10/2004 | Massara et al. | 7,767,656 | B2 | 8/2010 | Shoichet et al. |
| 6,809,085 | B1 | 10/2004 | Elson et al. | 7,815,949 | B2 | 10/2010 | Cohen |
| 6,818,226 | B2 | 11/2004 | Reed et al. | 7,829,115 | B2 | 11/2010 | Besins et al. |
| 6,841,716 | B1 | 1/2005 | Tsutsumi | RE42,012 | E | 12/2010 | Deaver et al. |
| 6,844,334 | B2 | 1/2005 | Hill et al. | 7,858,607 | B2 | 12/2010 | Mamchur |
| 6,855,703 | B1 | 2/2005 | Hill et al. | RE42,072 | E | 1/2011 | Deaver et al. |
| 6,860,859 | B2 | 3/2005 | Mehrotra et al. | 7,862,552 | B2 | 1/2011 | McIntyre et al. |
| 6,866,865 | B2 | 3/2005 | Hsia et al. | 7,867,990 | B2 | 1/2011 | Schultz et al. |
| 6,869,969 | B2 | 3/2005 | Huebner et al. | 7,879,830 | B2 | 2/2011 | Wiley |
| 6,878,518 | B2 | 4/2005 | Whitehead | 7,884,093 | B2 | 2/2011 | Creasy et al. |
| 6,901,278 | B1 | 5/2005 | Notelovitz | 7,939,104 | B2 | 5/2011 | Barbera et al. |
| 6,905,705 | B2 | 6/2005 | Palm et al. | 7,943,602 | B2 | 5/2011 | Bunschoten et al. |
| 6,911,438 | B2 | 6/2005 | Wright | 7,943,604 | B2 | 5/2011 | Coelingh Bennink et al. |
| 6,923,988 | B2 | 8/2005 | Patel et al. | 7,989,436 | B2 | 8/2011 | Hill et al. |
| 6,924,274 | B2 | 8/2005 | Lardy et al. | 7,989,487 | B2 | 8/2011 | Welsh et al. |
| 6,932,983 | B1 | 8/2005 | Straub et al. | 8,022,053 | B2 | 9/2011 | Mueller et al. |
| 6,939,558 | B2 | 9/2005 | Massara et al. | 8,048,869 | B2 | 11/2011 | Bunschoten et al. |
| 6,943,021 | B2 | 9/2005 | Klausner et al. | 8,071,729 | B2 | 12/2011 | Giles-Komar et al. |
| 6,958,327 | B1 | 10/2005 | Hillisch et al. | 8,076,319 | B2 | 12/2011 | Leonard |
| 6,962,691 | B1 | 11/2005 | Lulla et al. | 8,088,605 | B2 | 1/2012 | Beaudet et al. |
| 6,962,908 | B2 | 11/2005 | Aloba et al. | 8,101,209 | B2 | 1/2012 | Legrand et al. |
| 6,967,194 | B1 | 11/2005 | Matsuo et al. | 8,114,434 | B2 | 2/2012 | Sasaki et al. |
| 6,977,250 | B2 | 12/2005 | Rodriguez | 8,158,614 | B2 | 4/2012 | Lambert et al. |
| 6,978,945 | B2 | 12/2005 | Wong et al. | 8,202,736 | B2 | 6/2012 | Mousa et al. |
| 7,005,429 | B2 | 2/2006 | Dey et al. | 8,217,024 | B2 | 7/2012 | Ahmed et al. |
| 7,011,846 | B2 | 3/2006 | Shojaei et al. | 8,222,008 | B2 | 7/2012 | Thoenne |
| 7,018,992 | B2 | 3/2006 | Koch et al. | 8,227,454 | B2 | 7/2012 | Hill et al. |
| 7,030,157 | B2 | 4/2006 | Ke et al. | 8,227,509 | B2 | 7/2012 | Castro et al. |
| RE39,104 | E | 5/2006 | Duclos et al. | 8,241,664 | B2 | 8/2012 | Dudley et al. |
| 7,074,779 | B2 | 7/2006 | Sui et al. | 8,247,393 | B2 | 8/2012 | Ahmed et al. |
| 7,083,590 | B1 | 8/2006 | Bunt et al. | 8,273,730 | B2 | 9/2012 | Fernandez et al. |
| 7,091,213 | B2 | 8/2006 | Metcalf, III et al. | 8,287,888 | B2 | 10/2012 | Song et al. |
| 7,101,342 | B1 | 9/2006 | Caillouette | 8,329,680 | B2 | 12/2012 | Evans et al. |
| 7,135,190 | B2 | 11/2006 | Piao et al. | 8,349,820 | B2 | 1/2013 | Zeun et al. |
| 7,163,681 | B2 | 1/2007 | Giles-Komar et al. | 8,435,561 | B2 | 5/2013 | Besins et al. |
| 7,163,699 | B2 | 1/2007 | Besse | 2001/0005728 | A1 | 6/2001 | Guittard et al. |
| 7,179,799 | B2 | 2/2007 | Hill et al. | 2001/0021816 | A1 | 9/2001 | Caillouette |
| 7,196,074 | B2 | 3/2007 | Blye et al. | 2001/0027189 | A1 | 10/2001 | Bennink et al. |
| 7,198,801 | B2 | 4/2007 | Carrara et al. | 2001/0029357 | A1 | 10/2001 | Bunt et al. |
| 7,226,910 | B2 | 6/2007 | Wilson et al. | 2001/0031747 | A1 | 10/2001 | deZiegler et al. |
| 7,247,625 | B2 | 7/2007 | Zhang et al. | 2001/0034340 | A1 | 10/2001 | Pickar |
| 7,250,446 | B2 | 7/2007 | Sangita et al. | 2001/0056068 | A1 | 12/2001 | Chwalisz et al. |
| 7,300,926 | B2 | 11/2007 | Prokai et al. | 2002/0012710 | A1 | 1/2002 | Lansky |
| 7,303,763 | B2 | 12/2007 | Ho | 2002/0026158 | A1 | 2/2002 | Rathbone et al. |
| 7,317,037 | B2 | 1/2008 | Fensome et al. | 2002/0028788 | A1 | 3/2002 | Bunt et al. |
| 7,329,654 | B2 | 2/2008 | Kanojia et al. | 2002/0058648 | A1 | 5/2002 | Hammerly |
| 7,335,650 | B2 | 2/2008 | Potter et al. | 2002/0058926 | A1 | 5/2002 | Rathbone et al. |
| 7,374,779 | B2 | 5/2008 | Chen et al. | 2002/0076441 | A1 | 6/2002 | Shih et al. |
| 7,378,404 | B2 | 5/2008 | Peters et al. | 2002/0102308 | A1 | 8/2002 | Wei et al. |
| 7,387,789 | B2 | 6/2008 | Klose et al. | 2002/0107230 | A1 | 8/2002 | Waldon et al. |
| 7,388,006 | B2 | 6/2008 | Schmees et al. | 2002/0114803 | A1 | 8/2002 | Deaver et al. |
| 7,414,043 | B2 | 8/2008 | Kosemund et al. | 2002/0132801 | A1 | 9/2002 | Heil et al. |
| 7,427,413 | B2 | 9/2008 | Savoir et al. | 2002/0137749 | A1 | 9/2002 | Levinson et al. |
| 7,427,609 | B2 | 9/2008 | Leonard | 2002/0151530 | A1 | 10/2002 | Leonard et al. |
| 7,429,576 | B2 | 9/2008 | Labrie | 2002/0156394 | A1 | 10/2002 | Mehrotra et al. |
| 7,431,941 | B2 | 10/2008 | Besins et al. | 2002/0169150 | A1 | 11/2002 | Pickar |
| 7,459,445 | B2 | 12/2008 | Hill et al. | 2002/0173510 | A1 | 11/2002 | Levinson et al. |
| 7,465,587 | B2 | 12/2008 | Imrich | 2002/0193356 | A1 | 12/2002 | Van Beek et al. |
| 7,470,433 | B2 | 12/2008 | Carrara et al. | 2003/0004145 | A1 | 1/2003 | Leonard |
| 7,485,666 | B2 | 2/2009 | Villanueva et al. | 2003/0007994 | A1 | 1/2003 | Bunt et al. |
| 7,497,855 | B2 | 3/2009 | Ausiello et al. | 2003/0049307 | A1 | 3/2003 | Gyurik |
| 7,534,765 | B2 | 5/2009 | Gregg et al. | 2003/0064097 | A1 | 4/2003 | Patel et al. |
| 7,550,142 | B2 | 6/2009 | Giles-Komar et al. | 2003/0072760 | A1 | 4/2003 | Sirbasku |
| 7,563,565 | B1 | 7/2009 | Matsuo et al. | 2003/0073248 | A1 | 4/2003 | Roth et al. |
| 7,572,779 | B2 | 8/2009 | Aloba et al. | 2003/0073673 | A1 | 4/2003 | Hesch |
| 7,589,082 | B2 | 9/2009 | Savoir et al. | 2003/0077297 | A1* | 4/2003 | Chen et al. 424/400 |
| 7,671,027 | B2 | 3/2010 | Loumaye | 2003/0078245 | A1 | 4/2003 | Bennink et al. |
| 7,674,783 | B2 | 3/2010 | Hermesmyer | 2003/0091640 | A1 | 5/2003 | Ramanathan et al. |
| 7,687,281 | B2 | 3/2010 | Roth et al. | 2003/0092691 | A1 | 5/2003 | Besse et al. |
| 7,687,485 | B2 | 3/2010 | Levinson et al. | 2003/0096012 | A1 | 5/2003 | Besse et al. |
| 7,694,683 | B2 | 4/2010 | Callister et al. | 2003/0104048 | A1 | 6/2003 | Patel et al. |
| 7,704,983 | B1 | 4/2010 | Hodgen et al. | 2003/0114420 | A1 | 6/2003 | Salvati et al. |
| | | | | 2003/0124182 | A1 | 7/2003 | Shojaei et al. |
| | | | | 2003/0124191 | A1 | 7/2003 | Besse et al. |
| | | | | 2003/0130558 | A1 | 7/2003 | Massara et al. |
| | | | | 2003/0144258 | A1 | 7/2003 | Heil et al. |

(56)

References Cited

U.S. PATENT DOCUMENTS

| | | | | | | | |
|--------------|-----|---------|---------------------------|--------------|----|---------|------------------------|
| 2003/0157157 | A1 | 8/2003 | Luo et al. | 2006/0020002 | A1 | 1/2006 | Salvati et al. |
| 2003/0166509 | A1 | 9/2003 | Edwards et al. | 2006/0030615 | A1 | 2/2006 | Fensome et al. |
| 2003/0180352 | A1 | 9/2003 | Patel et al. | 2006/0051391 | A1 | 3/2006 | Dvoskin et al. |
| 2003/0181353 | A1 | 9/2003 | Nyce | 2006/0052341 | A1 | 3/2006 | Cornish et al. |
| 2003/0181728 | A1 | 9/2003 | Salvati et al. | 2006/0069031 | A1 | 3/2006 | Loumaye |
| 2003/0191096 | A1 | 10/2003 | Leonard et al. | 2006/0083778 | A1 | 4/2006 | Allison et al. |
| 2003/0195177 | A1 | 10/2003 | Leonard et al. | 2006/0089337 | A1 | 4/2006 | Casper et al. |
| 2003/0215496 | A1 | 11/2003 | Patel et al. | 2006/0093678 | A1 | 5/2006 | Chickering, III et al. |
| 2003/0220297 | A1 | 11/2003 | Berstein et al. | 2006/0106004 | A1 | 5/2006 | Brody et al. |
| 2003/0224057 | A1 | 12/2003 | Martin-Letellier et al. | 2006/0111424 | A1 | 5/2006 | Salvati et al. |
| 2003/0224059 | A1 | 12/2003 | Lerner et al. | 2006/0121626 | A1 | 6/2006 | Imrich |
| 2003/0225050 | A1* | 12/2003 | Grawe et al. 514/179 | 2006/0135619 | A1 | 6/2006 | Kick et al. |
| 2003/0228686 | A1 | 12/2003 | Klausner et al. | 2006/0194775 | A1 | 8/2006 | Tofovic et al. |
| 2003/0229057 | A1 | 12/2003 | Caubel et al. | 2006/0204557 | A1 | 9/2006 | Gupta et al. |
| 2004/0009960 | A1 | 1/2004 | Heil et al. | 2006/0235037 | A1 | 10/2006 | Purandare et al. |
| 2004/0034001 | A1 | 2/2004 | Karara | 2006/0240111 | A1 | 10/2006 | Fernandez et al. |
| 2004/0037881 | A1 | 2/2004 | Guittard et al. | 2006/0247216 | A1 | 11/2006 | Haj-Yehia |
| 2004/0043943 | A1 | 3/2004 | Guittard et al. | 2006/0252049 | A1 | 11/2006 | Shuler et al. |
| 2004/0044080 | A1 | 3/2004 | Place et al. | 2006/0257472 | A1 | 11/2006 | Nielsen |
| 2004/0073024 | A1 | 4/2004 | Metcalf, III et al. | 2006/0275360 | A1 | 12/2006 | Ahmed et al. |
| 2004/0077605 | A1 | 4/2004 | Salvati et al. | 2006/0280771 | A1 | 12/2006 | Groenewegen et al. |
| 2004/0077606 | A1 | 4/2004 | Salvati et al. | 2006/0280797 | A1 | 12/2006 | Shoichet et al. |
| 2004/0087548 | A1 | 5/2004 | Salvati et al. | 2006/0280800 | A1 | 12/2006 | Nagi et al. |
| 2004/0089308 | A1 | 5/2004 | Welch | 2007/0004693 | A1 | 1/2007 | Woolfson et al. |
| 2004/0092583 | A1 | 5/2004 | Shanahan-Prendergast | 2007/0004694 | A1 | 1/2007 | Woolfson et al. |
| 2004/0097468 | A1 | 5/2004 | Wimalawansa | 2007/0021360 | A1 | 1/2007 | Nyce et al. |
| 2004/0101557 | A1 | 5/2004 | Gibson et al. | 2007/0027201 | A1 | 2/2007 | McComas et al. |
| 2004/0106542 | A1 | 6/2004 | Deaver et al. | 2007/0031491 | A1 | 2/2007 | Levine et al. |
| 2004/0131670 | A1 | 7/2004 | Gao | 2007/0042038 | A1 | 2/2007 | Besse |
| 2004/0142012 | A1 | 7/2004 | Bunt et al. | 2007/0066628 | A1 | 3/2007 | Zhang et al. |
| 2004/0146894 | A1 | 7/2004 | Warrington et al. | 2007/0066637 | A1 | 3/2007 | Zhang et al. |
| 2004/0176324 | A1 | 9/2004 | Salvati et al. | 2007/0066675 | A1 | 3/2007 | Zhang et al. |
| 2004/0176336 | A1 | 9/2004 | Rodriguez | 2007/0093548 | A1 | 4/2007 | Diffendal et al. |
| 2004/0185104 | A1 | 9/2004 | Piao et al. | 2007/0116729 | A1 | 5/2007 | Palepu |
| 2004/0191276 | A1 | 9/2004 | Muni | 2007/0116829 | A1 | 5/2007 | Prakash et al. |
| 2004/0198706 | A1 | 10/2004 | Carrara et al. | 2007/0178166 | A1 | 8/2007 | Bernstein et al. |
| 2004/0213744 | A1 | 10/2004 | Lulla et al. | 2007/0184558 | A1 | 8/2007 | Roth et al. |
| 2004/0234606 | A1 | 11/2004 | Levine et al. | 2007/0191319 | A1 | 8/2007 | Ke et al. |
| 2004/0253319 | A1 | 12/2004 | Netke et al. | 2007/0196433 | A1 | 8/2007 | Ron et al. |
| 2004/0259817 | A1 | 12/2004 | Waldon et al. | 2007/0207225 | A1 | 9/2007 | Squadrito |
| 2004/0266745 | A1 | 12/2004 | Schwanitz et al. | 2007/0225281 | A1 | 9/2007 | Zhang et al. |
| 2005/0004088 | A1 | 1/2005 | Hesch | 2007/0238713 | A1 | 10/2007 | Gast et al. |
| 2005/0009800 | A1 | 1/2005 | Thumbek et al. | 2007/0243229 | A1 | 10/2007 | Smith et al. |
| 2005/0020552 | A1 | 1/2005 | Aschkenasy et al. | 2007/0264309 | A1 | 11/2007 | Chollet et al. |
| 2005/0021009 | A1 | 1/2005 | Massara et al. | 2007/0264345 | A1 | 11/2007 | Eros et al. |
| 2005/0025833 | A1 | 2/2005 | Aschkenasy et al. | 2007/0286819 | A1 | 12/2007 | DeVries et al. |
| 2005/0031651 | A1 | 2/2005 | Gervais et al. | 2007/0292387 | A1 | 12/2007 | Jon et al. |
| 2005/0042173 | A1 | 2/2005 | Besse et al. | 2008/0026035 | A1 | 1/2008 | Chollet et al. |
| 2005/0048116 | A1 | 3/2005 | Straub et al. | 2008/0026062 | A1 | 1/2008 | Farr et al. |
| 2005/0079138 | A1 | 4/2005 | Chickering, III et al. | 2008/0038350 | A1 | 2/2008 | Gerecke et al. |
| 2005/0085453 | A1 | 4/2005 | Govindarajan | 2008/0085877 | A1 | 4/2008 | Bortz |
| 2005/0101579 | A1 | 5/2005 | Shippen | 2008/0095838 | A1 | 4/2008 | Abou Chacra-Vernet |
| 2005/0113350 | A1 | 5/2005 | Duesterberg et al. | 2008/0113953 | A1 | 5/2008 | De Vries et al. |
| 2005/0118272 | A1 | 6/2005 | Besse et al. | 2008/0114050 | A1 | 5/2008 | Fensome et al. |
| 2005/0153946 | A1 | 7/2005 | Hirsh et al. | 2008/0119537 | A1 | 5/2008 | Zhang et al. |
| 2005/0164977 | A1 | 7/2005 | Coelingh Bennink | 2008/0125402 | A1 | 5/2008 | Diliberti |
| 2005/0182105 | A1 | 8/2005 | Nirschl et al. | 2008/0138379 | A1 | 6/2008 | Jennings-Spring |
| 2005/0187267 | A1 | 8/2005 | Hamann et al. | 2008/0145423 | A1 | 6/2008 | Khan et al. |
| 2005/0192253 | A1 | 9/2005 | Salvati et al. | 2008/0188829 | A1 | 8/2008 | Creasy |
| 2005/0192310 | A1 | 9/2005 | Gavai et al. | 2008/0206161 | A1 | 8/2008 | Tamarkin et al. |
| 2005/0207990 | A1 | 9/2005 | Funke et al. | 2008/0220069 | A1 | 9/2008 | Allison |
| 2005/0214384 | A1 | 9/2005 | Juturu et al. | 2008/0234199 | A1 | 9/2008 | Katamreddy |
| 2005/0220825 | A1 | 10/2005 | Funke et al. | 2008/0255078 | A1 | 10/2008 | Katamreddy |
| 2005/0222106 | A1 | 10/2005 | Bracht | 2008/0255089 | A1 | 10/2008 | Katamreddy |
| 2005/0244522 | A1 | 11/2005 | Carrara et al. | 2008/0299220 | A1 | 12/2008 | Tamarkin et al. |
| 2005/0245902 | A1 | 11/2005 | Cornish et al. | 2008/0312197 | A1 | 12/2008 | Rodriguez |
| 2005/0250746 | A1 | 11/2005 | Iammatteo | 2008/0312198 | A1 | 12/2008 | Rodriguez |
| 2005/0250750 | A1 | 11/2005 | Cummings et al. | 2009/0060982 | A1 | 3/2009 | Ron et al. |
| 2005/0250753 | A1 | 11/2005 | Fink et al. | 2009/0068118 | A1 | 3/2009 | Eini et al. |
| 2005/0256028 | A1 | 11/2005 | Yun et al. | 2009/0081278 | A1 | 3/2009 | De Graaff et al. |
| 2005/0266078 | A1 | 12/2005 | Jorda et al. | 2009/0081303 | A1 | 3/2009 | Savoir et al. |
| 2005/0272712 | A1 | 12/2005 | Grubb et al. | 2009/0092656 | A1 | 4/2009 | Klamerus et al. |
| 2006/0014728 | A1 | 1/2006 | Chwalisz et al. | 2009/0099106 | A1 | 4/2009 | Phiasivongsa et al. |
| 2006/0018937 | A1 | 1/2006 | Friedman et al. | 2009/0131385 | A1 | 5/2009 | Voskuhl |
| 2006/0019978 | A1 | 1/2006 | Balog | 2009/0137478 | A1 | 5/2009 | Bernstein et al. |
| | | | | 2009/0137538 | A1 | 5/2009 | Klamerus et al. |
| | | | | 2009/0143344 | A1 | 6/2009 | Chang |
| | | | | 2009/0181088 | A1 | 7/2009 | Song et al. |
| | | | | 2009/0214474 | A1 | 8/2009 | Jennings |

(56)

References Cited**U.S. PATENT DOCUMENTS**

2009/0227025 A1 9/2009 Nichols et al.
 2009/0232897 A1 9/2009 Sahoo et al.
 2009/0258096 A1 10/2009 Cohen
 2009/0264395 A1 10/2009 Creasy
 2009/0269403 A1 10/2009 Shaked et al.
 2009/0285772 A1 11/2009 Phiasivongsa et al.
 2009/0325916 A1 12/2009 Zhang et al.
 2010/0028360 A1 2/2010 Atwood
 2010/0040671 A1 2/2010 Ahmed et al.
 2010/0048523 A1 2/2010 Bachman et al.
 2010/0074959 A1 3/2010 Hansom et al.
 2010/0086599 A1 4/2010 Huempel et al.
 2010/0092568 A1 4/2010 Lerner et al.
 2010/0105071 A1 4/2010 Laufer et al.
 2010/0129320 A1 5/2010 Phiasivongsa et al.
 2010/0136105 A1 6/2010 Chen et al.
 2010/0137265 A1 6/2010 Leonard
 2010/0137271 A1 6/2010 Chen et al.
 2010/0152144 A1 6/2010 Hermesmeyer
 2010/0168228 A1 7/2010 Bose et al.
 2010/0183723 A1 7/2010 Laurent-Applegate et al.
 2010/0184736 A1 7/2010 Coelingh Bennink et al.
 2010/0190758 A1 7/2010 Fauser et al.
 2010/0240626 A1 9/2010 Kulkarni et al.
 2010/0255085 A1 10/2010 Liu et al.
 2010/0303825 A9 12/2010 Sirbasku
 2010/0312137 A1 12/2010 Gilmour et al.
 2010/0316724 A1 12/2010 Whitfield et al.
 2010/0330168 A1 12/2010 Gicquel et al.
 2011/0028439 A1 2/2011 Witt-Enderby et al.
 2011/0053845 A1 3/2011 Levine et al.
 2011/0076775 A1 3/2011 Stewart et al.
 2011/0076776 A1 3/2011 Stewart et al.
 2011/0086825 A1 4/2011 Chatroux
 2011/0091555 A1 4/2011 De Luigi Bruschi et al.
 2011/0098631 A1 4/2011 McIntyre et al.
 2011/0104289 A1 5/2011 Savoir Vilboeuf et al.
 2011/0135719 A1 6/2011 Besins et al.
 2011/0182997 A1 7/2011 Lewis et al.
 2011/0195114 A1 8/2011 Carrara et al.
 2011/0195944 A1 8/2011 Mura et al.
 2011/0217341 A1 9/2011 Sah
 2011/0250274 A1 10/2011 Shaked et al.
 2011/0256092 A1 10/2011 Phiasivongsa et al.
 2011/0262494 A1 10/2011 Achleitner et al.
 2011/0268665 A1 11/2011 Tamarkin et al.
 2011/0293720 A1 12/2011 General et al.
 2011/0311592 A1 12/2011 Birbara
 2011/0312927 A1 12/2011 Nachaegari et al.
 2011/0312928 A1 12/2011 Nachaegari et al.
 2012/0009276 A1 1/2012 De Groote
 2012/0015350 A1 1/2012 Nabatiyan et al.
 2012/0045532 A1 2/2012 Cohen
 2012/0052077 A1 3/2012 Truitt, III et al.
 2012/0128625 A1 5/2012 Shalwitz et al.
 2012/0128777 A1 5/2012 Keck et al.
 2012/0149748 A1 6/2012 Shanler et al.
 2012/0269721 A1 10/2012 Weng et al.
 2012/0269878 A2 10/2012 Cantor et al.
 2012/0283671 A1 11/2012 Shibata et al.
 2013/0022674 A1 1/2013 Dudley et al.
 2013/0029947 A1 1/2013 Nachaegari et al.
 2013/0129818 A1 5/2013 Bernick et al.

FOREIGN PATENT DOCUMENTS

IN 216026 3/2008
 IN 2005KO00053 9/2009
 IN 244217 11/2010
 WO 9011064 A1 10/1990
 WO 9317686 A1 9/1993
 WO 9422426 A1 3/1994
 WO 9530409 A1 11/1995
 WO 9609826 A2 4/1996

WO 9630000 A1 10/1996
 WO 9743989 A1 11/1997
 WO 9810293 A1 3/1998
 WO 9832465 A1 7/1998
 WO 9851280 A1 11/1998
 WO 9939700 A1 2/1999
 WO 9932072 A1 7/1999
 WO 9942109 A1 8/1999
 WO 9948477 A1 9/1999
 WO 9553910 A2 10/1999
 WO 0038659 A1 11/1999
 WO 9963974 A2 12/1999
 WO 0006175 A1 2/2000
 WO 0045795 A2 8/2000
 WO 0050007 A1 8/2000
 WO 0059577 A1 10/2000
 WO 0137808 A1 11/2000
 WO 0076522 A1 12/2000
 WO 0154699 A1 8/2001
 WO 0160325 A1 8/2001
 WO 0207700 A2 1/2002
 WO 0211768 A1 2/2002
 WO 0222132 A2 3/2002
 WO 0240008 A2 5/2002
 WO 02053131 A1 7/2002
 WO 03041718 A1 5/2003
 WO 03041741 A1 5/2003
 WO 03068186 A1 8/2003
 WO 03082254 A1 10/2003
 WO 03092588 A2 11/2003
 WO 2004017983 A1 3/2004
 WO 2005027911 A1 3/2004
 WO 2004032897 A2 4/2004
 WO 2004052336 A2 6/2004
 WO 2005120517 A1 6/2004
 WO 2004054540 A2 7/2004
 WO 2004080413 A2 9/2004
 WO 2005030175 A1 4/2005
 WO 2005087194 A1 9/2005
 WO 2005087199 A2 9/2005
 WO 2005105059 A1 11/2005
 WO 2005115335 A1 12/2005
 WO 2005120470 A1 12/2005
 WO 2006013369 A2 2/2006
 WO 2006034090 A1 3/2006
 WO 2006036899 A2 4/2006
 WO 2006053172 A2 5/2006
 WO 2006105615 A1 10/2006
 WO 2006113505 A2 10/2006
 WO 2006138686 A1 12/2006
 WO 2006138735 A2 12/2006
 WO 2007045027 A1 4/2007
 WO 2007103294 A2 9/2007
 WO 2007123790 A1 11/2007
 WO 2007124250 A2 11/2007
 WO 2007144151 A1 12/2007
 WO 2008049516 A3 5/2008
 WO 2008152444 A2 12/2008
 WO 2009002542 A1 12/2008
 WO 2009036311 A1 3/2009
 WO 2009069006 A2 6/2009
 WO 2009098072 A2 8/2009
 WO 2009133352 A2 11/2009
 WO 2010033188 A2 3/2010
 WO 2011000210 A1 1/2011
 WO 2011073995 A2 6/2011
 WO 2011120084 A1 10/2011
 WO 2011128336 A1 10/2011
 WO 2012009778 A2 1/2012
 WO 2012024361 A1 2/2012

OTHER PUBLICATIONS

Azure Pharma, Inc., "Elestrin™—Estradiol Gel" Drug Info, <http://dailymed.nlm.nih.gov/dailymed/archives/fdaDrugInfo.cfm?archiveid=11885>, 26 pages, 2009.
 Chun et al., "Transdermal Delivery of Estradiol and Norethindrone Acetate: Effect of Vehicles and Pressure Sensitive Adhesive Matrix," J. Kor. Pharm. Sci., 35(3):173-177, 2005.

(56)

References Cited**OTHER PUBLICATIONS**

Committee of Obstetric Practice, Committee Opinion—No. 522, *Obstetrics & Gynecology*, 119(4):879-882, 2012.

Diramio, "Polyethylene Glycol Methacrylate/Dimetacrylate Hydrogels for Controlled Release of Hydrophobic Drugs," The University of Georgia—Masters of Science Thesis, 131 pages, 2004. http://athenaeum.libs.uga.edu/bitstream/handle/10724/7820/diramio_jackie_a_200412_ms.pdf?sequence=1.

Ganem-Quintanar et al., "Evaluation of the transepidermal permeation of diethylene glycol monoethyl ether and skin water loss," *International Journal of Pharmaceutics*, 147(2):165-171, 1997. Abstract Only.

Johanson, "Toxicity Review of Ethylene Glycol Monomethyl Ether and its Acetate Ester," *Critical Reviews in Toxicology*, 30(3):307-345, 2000. Abstract Only.

Knuth et al., "Hydrogel delivery systems for vaginal and oral applications: Formulation and biological considerations," *Advanced Drug Delivery Reviews*, 11(1-2):137-167, 1993. Abstract Only.

Lucy et al., "Gonadotropin-releasing hormone at estrus: luteinizing hormone, estradiol, and progesterone during the periestrual and postinsemination periods in dairy cattle," *Biol Reprod.*, 35(2):300-11, 1986. Abstract Only.

NuGen, "What is NuGen HP Hair Growth System?" <http://www.skinenergizer.com/Nugen-HP-Hair-Growth-System-p/seusystem.htm>, 3 pages, undated.

NuGest 900™, <http://www.thehormoneshop.net/nugest900.htm>, 4 pages, undated.

Panchagnula et al., "Development and evaluation of an intracutaneous depot formulation of corticosteroids using Transcutol as a cosolvent: in-vitro, ex-vivo and in-vivo rat studies," *J Pharm Pharmacol.*;43(9):609-14, 1991. Abstract Only.

Salole, "The physiochemical properties of oestradiol," *Journal of Pharmaceutical & Biomedical Analysis*, 5(7):635-648, 1987.

Strickley, "Solubilizing Excipients in Oral and Injectable Formulations," *Pharmaceutical Research*, 21(2):201-230, 2004.

Tahition Noni, "Body Balance Cream," http://products.tni.com/dominican_republic/sa_spanish/nonistore/product/3438/3416/, 1 page, undated.

Trommer et al., "Overcoming the Stratum Corneum: The Modulation of Skin Penetration," *Skin Pharmacol Physiol.*, 19:106-121, 2006. http://www.nanobiotec.iqm.unicamp.br/download/Trommer_skin%20penetration-2006rev.pdf.

International Search report for corresponding International Application No. PCT/US12/66406, mailed Jan. 24, 2013.

International Search Report and Written Opinion for related International Application No. PCT/US13/023309 mailed Apr. 9, 2013.

Acarturk, "Mucoadhesive Vaginal Drug Delivery System," *Recent Patents on Drug Delivery & Formulation*, 3 (3):193-205, 2009.

Fuchs et al., "The Effects of an Estrogen and Glycolic Acid Cream on the Facial Skin of Postmenopausal Women: A Randomized Histologic Study," *Aesthetic Dermatology*, 8(1):14-19, 2006.

Panay et al., "The 2013 British Menopause Society & Women's Health Concern recommendations on hormone replacement therapy," DOI: 0.1177/1754045313489645, min.sagepub.com.

Menopause International: The Integrated Journal of Postreproductive Health 0(0):1-10, 2013.

Bhavnani et al., "Misconception and Concerns about Bioidentical Hormones Used for Custom-Compounded Hormone Therapy," *J Clin Endocrinol Metab.* doi:10.1210/jc.2011-2492, 97(3):0000-0000, 2011, 4 pages.

Bhavnani et al., "Structure Activity Relationships and Differential Interactions and Functional Activity of Various Equine Estrogens Mediated via Estrogen Receptors (ERs) ER α and ER β ," *Endocrinology* 2008;149(10):4857-4870.

Du et al., "Percutaneous progesterone delivery via cream or gel application in postmenopausal women: a randomized cross-over study of progesterone levels in serum, whole blood, saliva, and capillary blood," *Menopause: The Journal of the North American Menopause Society*, doi: 10.1097/gme.0b013e31828d39a2, 20(11):0000-0000, 2013, 7 pages.

Hargrove et al., "Menopausal Hormone Replacement Therapy With Continuous Daily Oral Micronize Estradiol and Progesterone," *Obstetrics & Gynecology: Estrogen Replacement Therapy* 1989;73(4):606-612.

Patel et al., "Transdermal Drug Delivery System: A Review," *The Pharma Innovation* 2012;1(4):78-87.

Sarrel et al., "The Mortality Toll of Estrogen Avoidance: An Analysis of Excess Deaths Among Hysterectomized Women Aged 50 to 59 Years," *American Journal of Public Health, Research and Practice*, e1-e6. doi:10.2105/AJPH.2013.301295, 2013.

Sitruk-Ware, "Progestogens in hormonal replacement therapy: new molecules, risks, and benefits," *Menopause: The Journal of The North American Menopause Society* 2002;9(1):6-15.

Stanczyk et al., "Ethinyl estradiol and 17 β -estradiol in combined oral contraceptives: pharmacokinetics, pharmacodynamics and risk assessment," *Elsevier* 2013;87:706-727.

Wood et al., "Effects of estradiol with micronized progesterone or medroxyprogesterone acetate on risk markers for breast cancer in postmenopausal monkeys," *Breast Cancer Res Treat* 2007;101:125-134.

Fotherby, "Bioavailability of Orally Administered Sex Steroids Used in Oral Contraception and Hormone Replacement Therapy," *Elsevier* 1996;54:59-69.

Kincl et al., "Increasing Oral Bioavailability of Progesterone by Formulation," *Journal of Steroid Biochemistry* 1978;9:83-84.

NAMS "Management of symptomatic vulvovaginal atrophy: 2013 position statement of The North American Menopause Society," *Menopause: The Journal of the North American Menopause Society* 2013;20(9):888-902.

Sitruk-Ware et al., "Oral Micronized Progesterone—Bioavailability pharmacokinetics, pharmacological and therapeutic implications—A review," *Contraception* 1987;36(4):373-402.

Shufelt et al., "Hormone therapy dose, formulation, route of delivery, and risk of cardiovascular events in women: findings from the Women's Health Initiative Observational Study," *Menopause: The Journal of The North American Menopause Society* 2013;DOI: 10.1097/GME.0b013e31829a64f9:1-7.

Smith et al., "Lower Risk of Cardiovascular Events in Postmenopausal Women Taking Oral Estradiol Compared With Oral Conjugated Equine Estrogens," *JAMA Internal Medicine* 2013;doi:10.1001/jamainternmed.2013.11074:E1-E7.

Whitehead et al., "Absorption and metabolism of oral progesterone," *British Medical Journal* 1980;825-827.

US 6,214,374, 04/2001, Schmirler et al. (withdrawn)

* cited by examiner

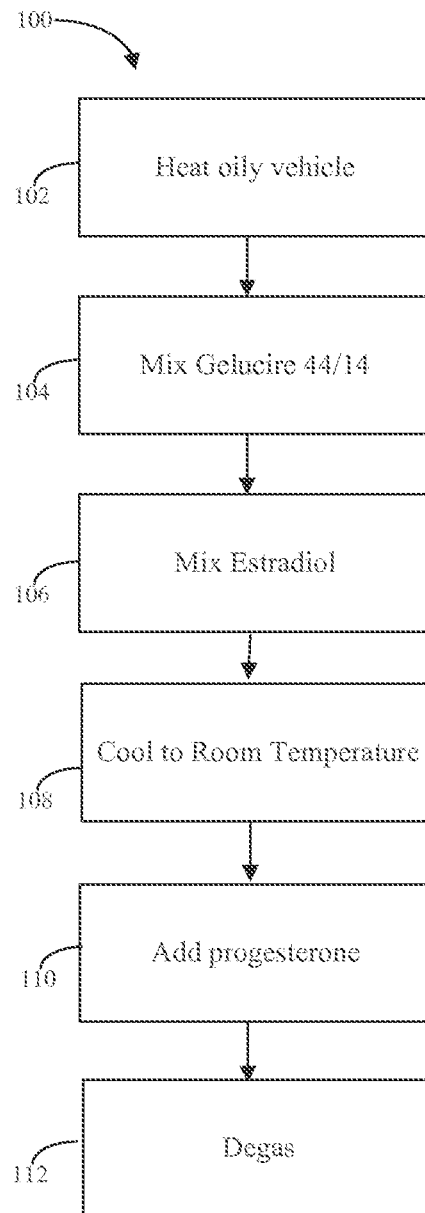


Fig. 1

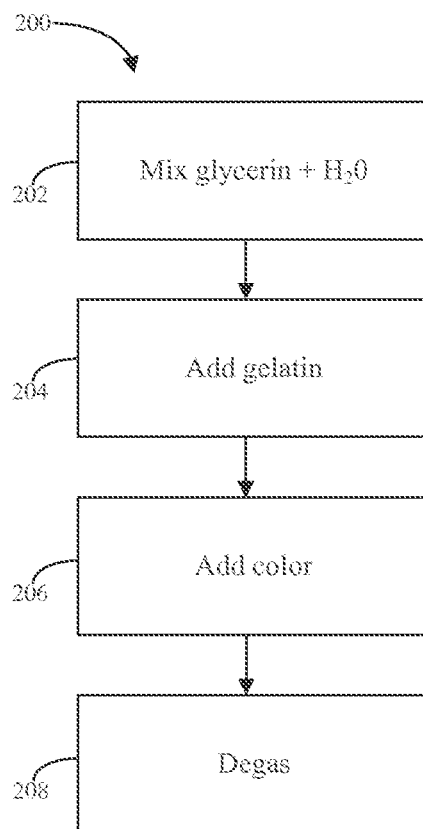


Fig. 2

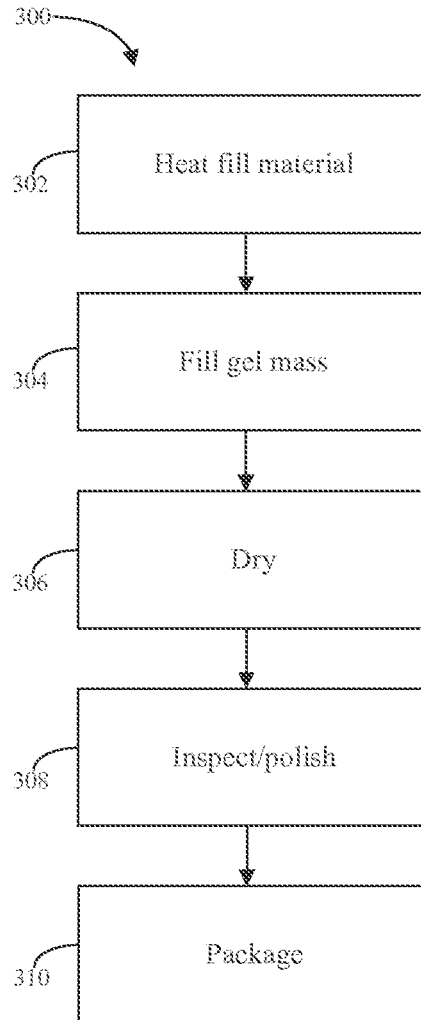


Fig. 3

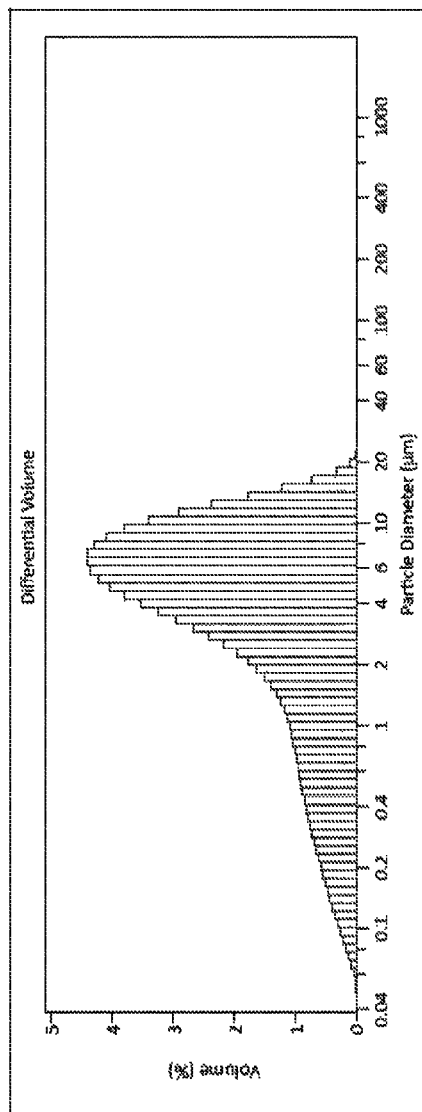


FIG. 4

1

NATURAL COMBINATION HORMONE REPLACEMENT FORMULATIONS AND THERAPIES

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a nonprovisional application of and claims priority to the following U.S. Provisional Patent Applications: U.S. Provisional Application Ser. No. 61/563,408, entitled "NATURAL COMBINATION HORMONE REPLACEMENT THERAPIES" which was filed on Nov. 23, 2011; U.S. Provisional Application Ser. No. 61/661,302, entitled "ESTRADIOL FORMULATIONS" which was filed on Jun. 18, 2012; and 3. U.S. Provisional Application Ser. No. 61/662,265, entitled "PROGESTERONE FORMULATIONS" which was filed on Jun. 20, 2012. All aforementioned applications are hereby incorporated by reference herein in their entirety.

BACKGROUND

1. Field

This disclosure relates to natural estrogen and progesterone replacement therapies, with formulations provided for each estradiol and progesterone alone and in combination for the treatment of pre, peri-menopausal, menopausal and post-menopausal females in relation to the treatment of Estrogen- and Progesterone-deficient States, each as herein below defined.

2. Discussion of the Related Art

Hormone replacement therapy (HRT) is a medical treatment that involves the use of one or more of a group of medications designed to increase hormone levels in women who lack adequate hormone production. HRT can mitigate and prevent symptoms caused by diminished circulating estrogen and progesterone hormones regardless as to whether the subject is pre-menopausal, peri-menopausal, menopausal or post-menopausal. However, specific disease states can exist during each stage of menopausal progression.

HRT is presently available in various forms. One therapy involves administration of low dosages of one or more estrogens. Another involves administration of progesterone or a chemical analogue, called a progestin. Progesterone administration acts, among treating other disease states, to mitigate certain undesirable side effects from estrogen administration including, for example, endometrial hyperplasia (thickening), reducing the incidence of endometrial cancer.

Timing for dosage administration is often varied cyclically, with estrogens taken daily and progesterone taken for approximately two weeks of every month; a method often referred to as "Cyclic-Sequential" or "Sequentially-Combined HRT." This method is intended to mimic the natural menstrual cycle and typically causes menstruation similar to a period after the progesterone is stopped. This regimen is most typically used in peri-menopausal or newly menopausal women as the alternative continuous method often results in irregular bleeding in such women. An alternate method, a constant dosage with both estrogen and progesterone taken daily, is called "continuous-combined HRT." This method usually results in no menstruation and is used most often after a woman has been menopausal for some time.

Estrogen, in its various forms, and progesterone, in its various forms, are used in HRT via a variety of administered dosage forms including, for example, via tablets, capsules and patches.

2

"Bio-identical" hormones, which are identical in chemical structure to the hormones naturally produced by human bodies can be used and are often referred to as natural hormone replacement therapy, or NHRT.

These natural or bio-identical hormones are formulated from various ingredients to match the chemical structure and effect of estradiol, estrone, or estriol (the 3 primary estrogens) as well as progesterone that occur naturally in the human body (endogenous).

Currently, bio-identical estradiol is available in both branded and generic FDA approved versions. FDA-approved bio-identical progesterone for HRT is available as the branded stand-alone drug commercially identified as PROMETRIUM (progesterone, USP) (Abbott Laboratories, Abbott Park, Ill.), with a generic authorized by the innovator, and generic products provided by Teva (Israel) and Sofgen Americas, Inc (New York). Other products such as PREM-PRO (conjugated estrogens/medroxyprogesterone acetate tablets) and PREMPHASE (conjugated estrogens plus medroxyprogesterone acetate tablets) (Wyeth Laboratories, a division Pfizer, Inc., New York) provide both continuous-combined and cyclic-sequential products containing PREMARIN (conjugated estrogens tablets) (estrogen derived from mare's urine) and synthetic medroxyprogesterone acetate. Other products are available. However, no FDA approved product exists on the market today with combination bio-identical estradiol and bio-identical progesterone.

SUMMARY

According to various embodiments of the disclosure, natural hormone replacement therapies are provided comprising cyclic/sequential and continuous-combined delivery via pharmaceutical formulations of solubilized estradiol and micronized and/or partially or completely solubilized progesterone. Estradiol and micronized and/or partially or completely solubilized progesterone delivered together daily can be combined in either a single unit dose or in separate unit doses, typically in a soft capsule. A 28-day or monthly regimen of tablets or capsules can be packaged in a single blister pack having delivery days identified to improve compliance. Various examples formulations of natural hormones, and the use of these formulations for hormone replacement therapies, each in accordance with the invention are set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

The accompanying drawings, which are incorporated herein and form a part of the specification, illustrate the present disclosure and, together with the description, further serve to explain the principles of the disclosure and to enable a person skilled in the pertinent art to make and use the disclosed embodiments.

FIG. 1 illustrates an exemplary manufacturing process of a fill material in accordance with various embodiments;

FIG. 2 illustrates an exemplary manufacturing process of a softgel material in accordance with various embodiments;

FIG. 3 illustrates an exemplary manufacturing process in accordance with various embodiments; and

FIG. 4 illustrates a graph of the particle distribution obtained in Example 10.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Frequently, higher recommended oral dosages of pharmaceuticals are necessary to treat a given disease state because

many active ingredients are not completely absorbed by a patient in need of treatment. In other words, a better-absorbed dosage form of a medicament such as, for example, progesterone, or dosage forms that provide greater consistency of absorption of progesterone among subjects, alone or in combination with estradiol, may be able to be administered at dosage strengths lower than presently recommended, potentially resulting in a reduced or minimized side effect profile, among other potential benefits.

DEFINITIONS

The term "micronized progesterone," as used herein, includes micronized progesterone having an X50 particle size value below about 15 microns and/or having an X90 particle size value below about 25 microns.

The term "X50," as used herein, means that one-half of the particles in a sample are smaller in diameter than a given number. For example, micronized progesterone having an X50 of 5 microns means that, for a given sample of micronized progesterone, one-half of the particles have a diameter of less than 5 microns. Similarly, the term "X90" means that ninety percent (90%) of the particles in a sample are smaller in diameter than a given number.

The term "medium chain," as used herein means any medium chain carbon-containing substance, including C4-C18, and including C6-C12 substances, fatty acid esters of glycerol, fatty acids, and mono-, di-, and tri-glycerides of such substances.

The term "uniform distribution" means at least one of uniform dispersion, solubility, or lack of agglomeration of progesterone in a dissolution test compared to PROMETRIUM (progesterone, USP) at a similar dosage strength and the same USP dissolution apparatus.

The term "bioavailability," as used herein means the concentration of an active ingredient (e.g., progesterone or estradiol or estrone) in the blood (serum or plasma). The relative bioavailability may be measured as the concentration in the blood (serum or plasma) versus time. Other pharmacokinetic (pK) indicators may be used to measure and assess bioavailability, determined by suitable metrics including AUC, C_{max} , and optionally, T_{max} .

The term "AUC," as used herein, refers to the area under the curve that represents changes in blood concentration of progesterone, estradiol or estrone over time.

The term, " C_{max} " as used herein, refers to the maximum value of blood concentration shown on the curve that represents changes in blood concentrations of progesterone, estradiol or estrone over time.

The term, " T_{max} " as used herein, refers to the time that it takes for progesterone, estradiol or estrone blood concentration to reach the maximum value.

Collectively AUC, C_{max} and, optionally, T_{max} are the principle pharmacokinetic parameters that can characterize the pharmacokinetic responses of a particular drug product such as progesterone in an animal or human subject.

The term "solubilizer," as used herein, means any substance or mixture of substances that may be used to enhance the solubility of estradiol, including, for example and without limitation, appropriate pharmaceutically acceptable excipients, such as solvents, co-solvents, surfactants, emulsifiers, oils and carriers.

The term "excipients," as used herein, refer to non-active pharmaceutical ingredients ("API") substances such as carriers, solvents, oils, lubricants and others used in formulating pharmaceutical products. They are generally safe for administering to animals, including humans, according to estab-

lished governmental standards, including those promulgated by the United States Food and Drug Administration.

The term "oil" as used herein may be any pharmaceutically acceptable substance, other than peanut oil, that would suspend and/or solubilize any suitable progesterone, starting material, or precursor, including micronized progesterone as described herein. More specifically, oils may include, for example and without limitation, medium chain fatty acids, generally of the group known as medium chain fatty acids consisting of at least one mono-, di-, and triglyceride, or derivatives thereof, or combinations thereof.

"Fully solubilized progesterone" as used herein means progesterone which is about 100% in solution.

"Partially solubilized progesterone" as used herein means progesterone which is in any state of solubilization up to but not including about 100%.

Description

Provided herein are the following formulations: solubilized estradiol without progesterone; micronized progesterone without estradiol; micronized progesterone with partially solubilized progesterone; solubilized estradiol with micronized progesterone; solubilized estradiol with micronized progesterone in combination with partially solubilized progesterone; and solubilized estradiol with solubilized progesterone. The underlying formulation concepts provided herein may be used with other natural or synthetic forms of estradiol and progesterone. Micronization specifications, aspects and embodiments are further defined herein.

Generally, the pharmaceutical formulations described herein are prepared and administered as filled capsules, typically soft capsules of one or more materials well known in the art including, for example and without limitation, soft gelatin capsules. Micronized progesterone, as described herein, may also be prepared for administration in tablets or other well-known orally administered dosage forms using standard techniques.

Another aspect of the present disclosure includes a pharmaceutical formulation of micronized progesterone, micronized progesterone with partially solubilized progesterone and fully solubilized progesterone, wherein said formulation may provide increased progesterone bioavailability in a treated subject compared to the bioavailability provided by PROMETRIUM (progesterone, USP) when administered at equal dosage strengths.

In accordance with various aspects and embodiments, the solubility proportion (i.e., the proportion of a solute that enters solution) is notable. The weight ratio of estradiol to the weight of the entire solution is also notable due to the intended dose amounts, discussed herein. In particular, it is desirable to obtain a target dosage of estradiol in an amount of solution that may be readily administered via a capsule. For example, if it is desired to have a dose of estradiol in a capsule of between about 0.125 mg to about 2 mg, it would also be desirable to have a total solution weight to be between about 250 mg to about 400 mg, preferably about 300 mg to about 350 mg and more preferably about 325 mg. In various embodiments, the following weight ratios of estradiol to total solution is from about 0.125/50 mg to about 0.125/1000 mg, from about 1 mg:500 mg to about 1 mg:50 mg; from about 1 mg:250 mg to about 1 mg:60 mg; from about 1 mg:100 mg to about 1 mg:66 mg; from about 2 mg/50 mg to about 2 mg/1000 mg. In various embodiments, the target for single dose product is 325 mg, and a target fill weight for a combination product (e.g., two or more sterol APIs) is 650 mg.

Other aspects of the present disclosure further provide: more uniform dissolution of progesterone, and reduced intra- and inter-patient blood level variability in formulations of

progesterone of the present disclosure, typically in combinations with solubilized estradiol, when compared to equal dosages of PROMETRIUM (progesterone, USP). Blood level variability is also compared at equal sampling times following administration. Not to be limited by theory, these aspects are believed to be influenced by the percentage of solubilized progesterone in a respective formulation wherein such more uniform dissolution of progesterone, and lower intra- and inter-patient blood level variability, are influenced by a greater proportion of solubilized progesterone relative to total progesterone. A reduced food effect with the present formulations comprising progesterone may also be implicated.

More uniform dissolution of progesterone in a formulation of the present disclosure compared to the dissolution of PROMETRIUM (progesterone, USP) equal dosage strengths and using the same USP apparatus can be determined using standard techniques established for API dissolution testing, including that which is described in the examples below.

Reduced intra- and inter-patient variability of progesterone formulated pursuant to the present disclosure compared to PROMETRIUM (progesterone, USP) can be demonstrated via a fed bio-study such as that described below.

Other aspects of the present disclosure includes the use of formulations as described herein wherein progesterone is at least one API in said formulation for the treatment of an animal, including humans: for endometrial hyperplasia; for secondary amenorrhea; as a method of treatment for preterm birth, when said animal has a shortened cervix, and other disease states or conditions treated with supplemental progesterone (collectively, "Progesterone-deficient States"); and the use of formulations as described herein wherein estradiol is at least one API in said formulation for the treatment of an animal, including humans, having menopause-related symptoms including, for example, vasomotor symptoms; in relation to treatment of hypoestrogenism related symptoms including, for example and without limitation, hot flashes and night sweats (vasomotor symptoms), sleep disturbances, mood changes and vulvo-vaginal atrophy; and osteoporosis and other non-menopausal disease states or conditions treated with supplemental estrogen. (collectively, "Estrogen-deficient States"), each in a subject in need of treatment, and each with a non-toxic effective amount of said formulations. As used herein, the term "treatment", or a derivative thereof, contemplates partial or complete inhibition of the stated disease state when a formulation as described herein is administered prophylactically or following the onset of the disease state for which such formulation is administered. For the purposes of the present disclosure, "prophylaxis" refers to administration of the active ingredient(s) to an animal to protect the animal from any of the disorders set forth herein, as well as others.

Unless otherwise specified, "natural," as used herein with reference to hormones discussed herein, means bio-identical hormones formulated to match the chemical structure and effect of those that occur naturally in the human body (endogenous). An exemplary natural estrogen is estradiol (also described as 17 β -estradiol and E2) and a natural progestin is progesterone. An exemplary cyclic/sequential regimen comprises delivery of from about 0.125 mg to about 2.0 mg of estradiol daily for 14-18 days, followed by delivery of from about 0.125 mg to about 2 mg of estradiol and about 25 mg to about 200 mg of progesterone daily for 10-14 days. Cyclic/sequential regimens may be especially useful for menopausal females. Other exemplary dosage strengths for estradiol for use in the formulations described herein include, without limitation, 0.125, 0.25, 0.375, 0.50, 0.625, 0.75, 1.00, 1.125,

1.25, 1.375, 1.50, 1.625, 1.75 and 2.00 mg. Other exemplary dosage strengths for progesterone for use in the formulations described herein include, without limitation, 25, 50, 75, 100, 125, 150, 175, 200 mg, 250 mg, 300 mg, 350 mg and 400 mg. These dosage strengths for each of estradiol and progesterone can be administered in formulations described herein either alone or in combination.

Progesterone active pharmaceutical ingredient may be micronized via any one of the multiple methods typically utilized by the ordinarily skilled artisan. In various embodiments, micronized progesterone has an X50 particle size value of less than about 15 microns, less than about 10 microns, less than about 5 microns and/or less than about 3 microns. In various embodiments, micronized progesterone has an X90 particle size value of less than about 25 microns, less than about 20 microns, and/or less than about 15 microns.

Particle size may be determined in any suitable manner. For example, a Beckman Coulter LS 13 320 Laser Diffraction Particle Size Analyzer (the "Beckman Device") may be used to determine particle size. As described above, particle size may be represented by various metrics, for example, through an X50 particle size, and/or X90 particle size, or similar descriptions of particle size.

The Beckman Device may be used with various modules for introducing a sample for analysis. The Beckman Device may be used with the LS 13 320 Universal Liquid Module ("ULM"). The ULM is capable of suspending samples in the size range of 0.017 μ m to 2000 μ m. The ULM is a liquid based module that allows for delivery of the sample to the sensing zone. The ULM recirculates the sample through the Beckman Device. The ULM comprises two hoses, one for fluid delivery and another for waste. The total volume used may be 125 mL or less. A sample mass of from about 1 mg to about 10 g may be used. The ULM may interact with the Beckman Device via pins that fit into slots on the ULM. The ULM may use a variety of suspension fluids, for example, water, butanol, ethanol, chloroform, heptanes, toluene, propanol, COULTER Type 1B Dispersant ("Coulter 1B"), and a variety of other suspension fluids. Surfactants may also be used, though pump speed should be adjusted to prevent excessive bubbling. Coulter 1B may comprise one or more of acetaldehyde, ethylene oxide, and/or 1,4-dioxane. The Beckman Device may be configured to use a variety of optical theories, including the Fraunhofer optical model and the Mie Theory.

The Beckman Device may comprise software to control the Beckman Device while the ULM is in use. The software may control, for example, pump speed, use of de-bubble routine, rinse routine, sonicate routine, and fill routine, among others. Parameters regarding the sample run may also be configured. For example, run length may be set. Though any suitable run length may be used, in various embodiments, a time period of 30 seconds to 120 seconds, and preferably between 30 seconds and 90 seconds may be used.

The Beckman Device may be used with the LS 13 320 Micro Liquid Module ("MLM"). The MLM is capable of suspending samples in the size range of 0.4 μ m to 2000 μ m. The MLM is a liquid based module that allows for delivery of the sample to the sensing zone. The MLM includes a stirrer. The total volume used may be 12 mL or less. The MLM may use a variety of suspension fluids, both aqueous and non-aqueous.

Each of estradiol and progesterone as described herein can be formulated alone pursuant to the teachings below. These formulations can be prepared for oral administration or can be combined, based on compatibility, for co-administration of estradiol and progesterone in a single oral unit dosage form.

Progesterone formulations of the present disclosure are prepared via blending with a pharmaceutically acceptable oil; generally, the oil comprises at least one medium chain fatty acid such as medium chain fatty acids consisting of at least one mono-, di-, or triglyceride, or derivatives thereof, or combinations thereof. Optionally added are other excipients including, for example and without limitation, anti-oxidants, lubricants and the like. Sufficient oil is used to form a suspension of micronized progesterone or, in the alternative, solubilize progesterone.

Pharmaceutically acceptable oils include, without limitation, the use of at least one of a caproic fatty acid; a caprylic fatty acid; a capric fatty acid; a tauric acid; a myristic acid; a linoleic acid; a succinic acid; a glycerin; mono-, di-, or triglycerides and combinations and derivatives thereof; a polyethylene glycol; a polyethylene glycol glyceride (GELUCIRE (a polyethylene glycol glyceride); GATTEFOSSE SAS, Saint-Priest, France); a propylene glycol; a caprylic/capric triglyceride (MIGLYOL (caprylic/capric triglyceride); SASOL Germany GMBH, Hamburg; MIGLYOL (caprylic/capric triglyceride) includes MIGLYOL 810 (Caprylic/Capric Triglyceride), MIGLYOL 812 (Caprylic/Capric Triglyceride), MIGLYOL 816 (Caprylic/Capric Triglyceride) and MIGLYOL 829 (Caprylic/Capric/Succinic Triglyceride); a caproic/caprylic/capric/lauric triglyceride; a caprylic/capric/linoleic triglyceride; a caprylic/capric/succinic triglyceride; a propylene glycol monocaprylate; propylene glycol monocaprate; (CAPMUL PG-8 (Propylene Glycol Monocaprylate) and CAPMUL PG-10 (Propylene Glycol Monocaprate); the CAPMUL brands are owned by ABITEC, Columbus Ohio); a propylene glycol dicaprylate; a propylene glycol dicaprylate; medium chain mono- and di-glycerides (CAPMUL MCM (Medium Chain Mono- and Diglycerides)); a diethylene glycol mono ester (including 2-(2-Ethoxyethoxy)ethanol: TRANSCUTOL (diethylene glycol mono ester)); a diethylene glycol monoethyl; esters of saturated coconut and palm kernel oil and derivatives thereof triglycerides of fractionated vegetable fatty acids, and combinations and derivatives thereof.

In other aspects and embodiments, progesterone is fully solubilized using, for example and without limitation, sufficient amounts of: TRANSCUTOL (Diethylene glycol monoethyl ether) and MIGLYOL (caprylic/capric triglyceride); TRANSCUTOL (Diethylene glycol monoethyl ether), MIGLYOL (caprylic/capric triglyceride) and CAPMUL PG-8 (Propylene Glycol Monocaprylate) and/or CAPMUL PG-10 (Propylene Glycol Monocaprate); CAPMUL MCM (Medium Chain Mono- and Diglycerides); CAPMUL MCM (Medium Chain Mono- and Diglycerides) and a non-ionic surfactant; and CAPMUL MCM (Medium Chain Mono- and Diglycerides) and GELUCIRE (a polyethylene glycol glyceride).

Various ratios of these oils can be used for full solubilization of progesterone. CAPMUL MCM (Medium Chain Mono- and Diglycerides) and a non-ionic surfactant can be used at ratios including, for example and without limitation: 65:35, 70:30, 75:25, 80:20, 85:15 and 90:10. CAPMUL MCM (Medium Chain Mono- and Diglycerides) and GELUCIRE (a polyethylene glycol glyceride) can be used at ratios including, for example and without limitation, 6:4, 7:3, 8:2, and 9:1. Among other combinations, these oils and/or solubilizers, as defined herein, and combinations thereof, can be used to form combination estradiol and progesterone formulations of the present disclosure.

Combinations of these oils can produce partially solubilized progesterone, depending upon the desired unit dosage amount of progesterone. The greater the amount of progest-

erone per unit dosage form, the less progesterone may be solubilized. The upward limit of dosage strength per unit dose is generally limited only by the practical size of the final dosage form.

In various embodiments, estradiol is partially, substantially or completely solubilized. Solubilized estradiol may include estradiol that is approximately: 90% soluble in a solvent; 93% soluble in a solvent; 95% soluble in a solvent; 97% soluble in a solvent; 99% soluble in a solvent; and 100% soluble in a solvent. Solubility may be expressed as a mass fraction (% w/w).

In various embodiments, the solubilizing agent is selected from at least one of a solvent or co-solvent. Suitable solvents and co-solvents include any mono-, di- or triglyceride and glycols, and combinations thereof.

In addition to the oils referenced above for progesterone, which can also be used as solubilizers for estradiol, other solubilizers include, for example and without limitation, glyceryl mono- and di-caprylates, propylene glycol and 1,2,3-propanetriol (glycerol, glycerin, glycerine).

Anionic and/or non-ionic surfactants can be used in other embodiments of the presently disclosed formulations containing estradiol, progesterone or a combination thereof. In certain embodiments, a non-ionic surfactant is used. Exemplary non-ionic surfactants may include, for example and without limitation, one or more of oleic acid, linoleic acid, palmitic acid, and stearic acid. In further embodiments, the non-ionic surfactant may comprise polyethylene sorbitol esters, including polysorbate 80, which is commercially available under the trademark TWEEN 80® (Sigma Aldrich, St. Louis, Mo.). Polysorbate 80 comprises approximately 60%-70% oleic acid with the remainder comprising primarily linoleic acids, palmitic acids, and stearic acids. Polysorbate 80 may be used in amounts ranging from about 5 to 50%, and in certain embodiments, about 30% of the formulation total mass.

In various other embodiments, the non-ionic surfactant is selected from one or more of glycerol and polyethylene glycol esters of long chain fatty acids, for example, lauroyl macrogol-32 glycerides and/or lauroyl polyoxyl-32 glycerides, commercially available as Gelucire, including, for example, Gelucire 44/11 and Gelucire 44/14. These surfactants may be used at concentrations greater than about 0.01%, and typically in various amounts of about 0.01%-10.0%, 10.1%-20%, and 20.1%-30%.

In other embodiments, a lubricant is used. Any suitable lubricant may be used, such as for example lecithin. Lecithin may comprise a mixture of phospholipids.

In additional embodiments, an antioxidant is used. Any suitable anti-oxidant may be used such as, for example and without limitation butylated hydroxytoluene.

For example, in various embodiments, a pharmaceutical formulation comprises about 20% to about 80% carrier by weight, about 0.1% to about 5% lubricant by weight, and about 0.01% to about 0.1% antioxidant by weight.

The choice of excipient will, to a large extent, depend on factors such as the particular mode of administration, the effect of the excipient on solubility and stability, and the nature of the dosage form. Excipients used in various embodiments may include colorants, flavoring agents, preservatives and taste-masking agents. Colorants, for example, may comprise about 0.1% to about 2% by weight. Preservatives may comprise methyl and propyl paraben, for example, in a ratio of about 10:1, and at a proportion of about 0.005% and 0.05% by weight.

As is with all oils, solubilizers, excipients and any other additives used in the formulations described herein, each is to be non-toxic and pharmaceutically acceptable.

As referenced above, the formulations of the present disclosure are generally orally administered, typically via, for example, capsules such as soft capsules. The present formulations can also be used to form transdermal patches using standard technology known in the art. Solubilized formulations of the present invention can also be formulated for intraperitoneal administration using techniques well known in the art.

In accordance with various embodiments, formulations do not include peanut oil. The lack of peanut oil obviates the risk posed to those having peanut-based allergies.

According to various embodiments described herein, a 28-day or monthly regimen of capsules can be packaged in a single kit (e.g., a blister pack) having administration days identified to improve compliance and reduce associated symptoms, among others. One or more of the capsules may contain no estradiol, for example, and/or no progesterone. Capsules that comprise no estrogen or progesterone API may be referred to as placebos. A blister pack can have a plurality of scores or perforations separating blister pack into 28 days. Each day may further comprise a single blister or a plurality of blisters. In various embodiments, each unit dose may contain micronized and/or partially solubilized, or fully solubilized progesterone and/or solubilized estradiol in amounts as set forth herein above, although other dose ranges may be contemplated. In addition, kits having other configurations are also contemplated herein. For example, without limitation, kits having such blister packs may contain any number of capsules.

Orally administered formulations of the present disclosure containing micronized and/or partially solubilized, or fully solubilized, progesterone are also used for the treatment of endometrial hyperplasia, secondary amenorrhea and other disease states treated with supplemental progesterone. Generally, progesterone-containing formulations described herein are used to treat the effects of the administration of supplemental estrogen whether administered alone or in combination with solubilized estradiol of the present disclosure or other estrogen-containing formulations. In various other embodiments, a capsule containing formulations of the present disclosure, for example a softgel capsule, may be applied in or around the vagina.

Formulations of the present disclosure containing solubilized estradiol are used to treat Estrogen-deficient States, including vasomotor symptoms, for example, in relation to treatment of hypoestrogenism related symptoms including, for example and without limitation, hot flashes and night sweats (vasomotor symptoms), sleep disturbances, mood changes, vulvo-vaginal atrophy, and osteoporosis and other non-menopausal disease states treated with supplemental estrogen.

Formulations of the present disclosure containing solubilized estradiol may be used to treat or prevent atrophic vaginitis or vulvo-vaginal atrophy. In various embodiments, a capsule, for example a softgel capsule, may be applied in or around the vagina.

Additional objects of the present disclosure includes: providing increased patient compliance secondary to ease of use; providing increased physician adoption secondary to ease of use/instruction with less worry of side effects from inappropriate usage; providing decreased side-effects from erroneous use (decreased irregular bleeding); providing better efficacy/control of symptoms secondary to appropriate use; reducing the metabolic and vascular side effects of the com-

monly used synthetic progestins when administered alone or in combination with an estrogen (norethindrone acetate, medroxyprogesterone acetate, etc.) including, for example, stroke, heart attacks, blood clots and breast cancer.

EXAMPLES

Example 1

Estradiol Solubility

In various experiments, suitable solvents were determined for providing sufficient solubility to make 2 mg of estradiol in a 100 mg fill mass, with a desired goal of achieving ~20 mg/g solubility for estradiol. Initial solubility experiments were done by mixing estradiol with various solvents, saturate the solution with the estradiol, equilibrate for at least 3 days and filter the un-dissolved particles and analyzing the clear supernatant for the amount of estradiol dissolved by HPLC.

Estradiol solubility experiments were performed. From this list at least one item (e.g. propylene glycol) is known to be unsuitable for encapsulation.

TABLE 1

| Ingredient | Solubility (mg/g) |
|---|-------------------|
| PEG 400 | 105* |
| Propylene Glycol | 75* |
| Polysorbate 80 | 36* |
| TRANSCUTOL HP | 141 |
| (Highly purified diethylene glycol monoethyl ether EP/NF) | |
| CAPMUL PG-8 (Propylene Glycol Monocaprylate) | 31.2 |

*Literature reference—Salole, E. G. (1987) The Physicochemical Properties of Oestradiol, J Pharm and Biomed Analysis, 5, 635-640.

Example 2

It was desired to achieve 50 mg of progesterone suspended in a medium that can also solubilize 2 mg estradiol in a total capsule fill mass of 200 mg. In order to achieve this formulation, the required solubility of estradiol needs to be ~10 mg/g. A total fill weight of 200 mg was considered suitable for a size 5 oval soft gelatin capsule.

Additional solubility studies were performed to find solvent mixtures that might possibly be more suitable for soft gelatin encapsulation. Solubility studies were conducted with CAPMUL PG-8 (Propylene Glycol Monocaprylate) and CAPMUL MCM (Medium Chain Mono- and Diglycerides) by mixing estradiol with various the solvent systems and as before by analyzing for the amount of estradiol dissolved by HPLC after filtration. Results of these experiments are presented in Table 2. It can be seen from these results that mixtures containing MIGLYOL (caprylic/capric triglyceride):CAPMUL PG-8 (Propylene Glycol Monocaprylate) at 50%; and also CAPMUL MCM (Medium Chain Mono- and Diglycerides) alone or in combination with 20% Polysorbate 80 can achieve sufficient solubility to meet the target of 10 mg/g. CAPMUL PG-8 (Propylene Glycol Monocaprylate) mixed with MIGLYOL (caprylic/capric triglyceride) at the 15 and 30% level did not provide sufficient solubility.

11

TABLE 2

| Ingredient | Solubility (mg/g) |
|---|-------------------|
| MIGLYOL (caprylic/capric triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (85:15) | 4.40 |
| MIGLYOL (caprylic/capric triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (70:30) | 8.60 |
| TRANSCUTOL (Diethylene glycol monoethyl ether) MIGLYOL 812 (Caprylic/Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (5:65:28) | >12 |
| TRANSCUTOL (Diethylene glycol monoethyl ether) MIGLYOL 812 (Caprylic/Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (5:47:47) | >12 |
| MIGLYOL (caprylic/capric triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (50:50) | 14.0 |
| CAPMUL MCM (Medium Chain Mono- and Diglycerides) | 19.8 |
| polysorbate 80: CAPMUL MCM (Medium Chain Mono- and Diglycerides) (20:80) | 15.0 |

Example 3

Additional studies were performed to assess the stability of estradiol (4-6 mg) in solvent mixtures, as reported in Table 3. MIGLYOL 812 (Caprylic/Capric Triglyceride) with 4% TRANSCUTOL (Diethylene glycol monoethyl ether) precipitated on Hot/Cold cycling after 96 hours, while estradiol solubilized in MIGLYOL (caprylic/capric triglyceride): CAPMUL (a propylene glycol monocaprylate; propylene glycol monocaprylate) blends at 30 and 50% or in CAPMUL MCM (Medium Chain Mono- and Diglycerides) alone, did not precipitate under the same conditions for a minimum of 14 days.

TABLE 3

| Formulation | Estradiol mg/g | Results Hot/Cold Cycling |
|---|-------------------|-----------------------------|
| TRANSCUTOL (Diethylene glycol monoethyl ether) MIGLYOL 812 (Caprylic/ Capric Triglyceride) (4:96) | 4 | Crystallizes after 96 hours |
| MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (70:30) | 6 | Clear, after 14 days |
| MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (50:50) | 6 | Clear, after 14 days |
| TRANSCUTOL (Diethylene glycol monoethyl ether) MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (5:80:15) | 6 | Clear, after 14 days |
| CAPMUL MCM(Medium Chain Mono- and Diglycerides) | 6 | Clear, after 14 days |

12 mg estradiol solubilized in MIGLYOL (caprylic/capric triglyceride):CAPMUL PG-8 (Propylene Glycol Monocaprylate) 50:50, CAPMUL MCM (Medium Chain Mono- and Diglycerides), and in mixtures of TRANSCUTOL (Diethyl-

12

ene glycol monoethyl ether):MIGLYOL (caprylic/capric triglyceride):CAPMUL PG-8 (Propylene Glycol Monocaprylate) are stable and do not precipitate for at least 12 days.

TABLE 4

| Formulation | Estradiol mg/g | Results Hot/Cold Cycling |
|--|-------------------|--------------------------|
| MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (50:50) | 12 | Clear, after 12 days |
| TRANSCUTOL (Diethylene glycol monoethyl ether) MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (5:65:28) | 12 | Clear, after 12 days |
| TRANSCUTOL (Diethylene glycol monoethyl ether): MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (5:80:15) | 12 | Clear, after 12 days |
| CAPMUL MCM(Medium Chain Mono- and Diglycerides) | 12 | Clear, after 12 days |

Example 4

In addition to determining physical stability of the estradiol solutions over time, it is necessary to determine if the fill material will be stable during the encapsulation process. One way to test these preparations is with the addition of water to the fill mass. As can be seen in Table 5, estradiol solutions at a concentration of 6 mg/g in Polyethylene Glycol 400 and CAPMUL MCM (Medium Chain Mono- and Diglycerides) are able to absorb a minimum of 7% water without recrystallization, whereas the same concentration in MIGLYOL 812 (Caprylic/Capric Triglyceride):CAPMUL PG-8 (Propylene Glycol Monocaprylate) (75:25) precipitates.

Estradiol solutions at a concentration of 12 mg/g in Polyethylene Glycol 400 and CAPMUL MCM (Medium Chain Mono- and Diglycerides) are able to absorb a minimum of 7% water without recrystallization. All CAPMUL PG-8 (Propylene Glycol Monocaprylate) containing formulations turned hazy on the addition of water. However, it should be noted that estradiol recrystallization was not observed, and the addition of water to CAPMUL PG-8 (Propylene Glycol Monocaprylate) alone (without any estradiol) also turns hazy on the addition of water.

TABLE 5

| Formulation | Estradiol mg/g | Results after addition of 7% water |
|---|-------------------|---------------------------------------|
| MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (75:25) | 6 | Precipitated |
| MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (50:50) | 12 | Hazy |

13

TABLE 5-continued

| Formulation | Estradiol mg/g | Results after addition of 7% water |
|--|-------------------|---------------------------------------|
| TRANSCUTOL (Diethylene glycol monoethyl ether): MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (5:65:28) CAPMUL MCM(Medium Chain Mono- and Diglycerides) | 12 | Hazy |
| TRANSCUTOL (Diethylene glycol monoethyl ether) MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (5:47:47) | 12 | Clear |
| TRANSCUTOL (Diethylene glycol monoethyl ether) MIGLYOL 812 (Caprylic/ Capric Triglyceride): CAPMUL PG-8 (Propylene Glycol Monocaprylate) (5:47:47) | 12 | Hazy |

Example 5

In an exemplary embodiment, a capsule is provided containing a fill material comprising:

TABLE 6

| Ingredient | Mg/Capsule |
|--|------------|
| Estradiol Hemihydrate | 2.00 |
| Mono-, di- or triglyceride (Miglyol 812) | qs |
| Diethylene Glycol Monoethylether (TRANSCUTOL HP) (Highly purified diethylene glycol monoethyl ether EP/NF) | 65.00 |
| Liquid lecithin | 1.63 |
| Butylated Hydroxytoluene | 0.13 |
| Total Fill Weight | 325 |

Example 6

In an exemplary embodiment, a capsule is provided containing a fill material comprising:

TABLE 7

| Ingredient | Mg/Capsule |
|--|------------|
| Estradiol Hemihydrate | 2.00 |
| Monoglycerides/diglycerides/triglycerides of caprylic/capric acid (CAPMUL MCM) (Medium Chain Mono- and Diglycerides) | qs |
| Liquid lecithin | 1.63 |
| Polysorbate 80 | 97.5 |
| Total Fill Weight | 325 |

14

In an exemplary embodiment, a capsule is provided containing a fill material comprising:

TABLE 8

| Ingredient | Mg/ Capsule | % w/w | Amount/ Batch |
|--|----------------|-------|------------------|
| Estradiol Hemihydrate | 2.03 | 0.62 | 20.2 g |
| Monoglycerides/diglycerides/triglycerides of caprylic/capric acid (CAPMUL MCM) (Medium Chain Mono- and Diglycerides) | 322.97 | 99.38 | 3.23 kg |
| Total | | 100 | 3.25 kg |

The above formulation is prepared as follows: estradiol is added to CAPMUL MCM (Medium Chain Mono- and Diglycerides) and mixed until dissolved.

Example 7

Progesterone Solubility

In various embodiments, both estradiol and progesterone may be dissolved in a solvent. In various embodiments, the solubility of both estradiol and progesterone will be such that a therapeutically effective dose may be obtained in a reasonably sized mass, generally considered to be between 1 mg and 1200 mg, preferably suitable for encapsulation in a size 3 to 22 oval or oblong capsule. For example, in various embodiments, 50 mg to 100 mg of progesterone may be dissolved in a volume of solvent; i.e., the solubility would be 50 mg to 100 mg per capsule. MIGLYOL (caprylic/capric triglyceride) was attempted, and while it can be considered a good carrier for progesterone, it alone did not provide a desirable level of solubilization of estradiol (e.g., solubility of 12 mg/g may be desirable in various embodiments). Thus, MIGLYOL (caprylic/capric triglyceride) may be used in embodiments comprising a suspension of progesterone, though MIGLYOL (caprylic/capric triglyceride), standing alone, is not desirable for use in embodiments having fully solubilized progesterone and/or estradiol.

As can be seen in Table 9, the solubility of progesterone in CAPMUL MCM (Medium Chain Mono- and Diglycerides) is ~73 mg/g. Therefore, by suspending 200 mg progesterone in 400 mg of solvent, part of the dose (~14%) is already dissolved and the remaining is still a suspension. In some aspects and embodiments, it is desired to minimize the partial solubility of progesterone in the formulation in order to minimize the possibility of recrystallization.

Based on 73 mg/g solubility, the capsule size required to make a capsule of 50 mg solubilized progesterone would be 685 mg. Therefore, it was shown that it would be feasible to make a 50 mg progesterone and 2 mg estradiol solubilized formulation. MIGLYOL (caprylic/capric triglyceride) had the lowest solubility, but that solvent is unable to dissolve the estradiol, therefore under further experiments, it was decided to proceed with the second lowest or CAPMUL MCM (Medium Chain Mono- and Diglycerides). It has also been found that 2 mg of estradiol may also be dissolved in 685 mg of CAPMUL MCM (Medium Chain Mono- and Diglycerides).

15

TABLE 9

| Ingredient | Progesterone Solubility (mg/g) |
|--|--------------------------------|
| CAPMUL MCM (Medium Chain Mono- and Diglycerides) | 73.4 |
| CAPMUL PG-8 (Propylene Glycol Monocaprylate) | 95 |
| MIGLYOL 812 (Caprylic/ Capric Triglyceride) | 27.8 |

In addition, it has been found that the solubility of progesterone in a solvent of CAPMUL MCM (Medium Chain Mono- and Diglycerides) in combination with Gelucire 44/14 in a 9:1 ratio increases the solubility to approximately 86 mg/g. Therefore, in various embodiments, progesterone and/or estradiol may be dissolved in a CAPMUL MCM (Medium Chain Mono- and Diglycerides) and Gelucire 44/14 system, wherein the ratio of CAPMUL MCM (Medium Chain Mono- and Diglycerides) to GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) is 9:1.

TABLE 10

| Ingredient | Progesterone Solubility (mg/g) |
|--|--------------------------------|
| CAPMUL MCM (Medium Chain Mono- and Diglycerides): GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG) (9:1) | 86.4 |
| CAPMUL MCM (Medium Chain Mono- and Diglycerides): GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG) (7:3) | 70.5 |
| CAPMUL MCM (Medium Chain Mono- and Diglycerides): GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) (6:4) | 57.4 |

Example 7

In an exemplary embodiment, a capsule is provided containing a fill material having fully solubilized progesterone and estradiol comprising:

TABLE 11

| Ingredient | Mass (mg) | % w/w | Qty/Capsule (mg) |
|---|-----------|--------|------------------|
| Progesterone, USP, micronized | 50.00 | 7.14 | 50.00 |
| Estradiol Hemihydrate, USP | 2.03 | 0.29 | 2.03 |
| CAPMUL MCM (Medium Chain Mono- and Diglycerides), NF | | 82.57 | 577.97 |
| GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)), NF | | 10.0 | 70.00 |
| TOTAL | | 100.00 | 700.00 |

A capsule such as that shown in TABLE 11 may be manufactured in any suitable manner. For the purposes of this

16

Example, mixing may be facilitated by an impellor, agitator, or other suitable means. Also for the purposes of this Example, heating and/or mixing may be performed under an inert or relatively inert gas atmosphere, such as nitrogen gas N₂. Mixing and/or heating for the purposes of this Example may be performed in any suitable vessel, such as a stainless steel vessel.

For example, CAPMUL MCM (Medium Chain Mono- and Diglycerides) may be heated to between 30° C. to 50° C., more preferably from 35° C. to 45° C., and more preferably to 40° C. +/-2° C. GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) may be added to the CAPMUL MCM (Medium Chain Mono- and Diglycerides) and mixed until dissolved. The addition may occur all at once or may occur gradually over a period of time. Heat may continue to be applied during the mixing of the Gelucire 44/14 and the CAPMUL MCM (Medium Chain Mono- and Diglycerides).

Heat may be removed from the GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) and CAPMUL MCM (Medium Chain Mono- and Diglycerides) mixture. Estradiol Hemihydrate may be added to the mixture. The addition may occur all at once or may occur gradually over a period of time. Micronized progesterone may then be added to the Gelucire 44/14, CAPMUL MCM (Medium Chain Mono- and Diglycerides) and Estradiol Hemihydrate mixture until dissolved. The addition may occur all at once or may occur gradually over a period of time.

Example 8

In an exemplary embodiment, a capsule is provided containing a fill material having suspended progesterone comprising:

TABLE 12

| Ingredient | mg/ Capsule | % | Function |
|--|-------------|-------|-----------------------|
| Micronized Progesterone | 200.00 | 30.77 | Active |
| Medium Chain Triglyceride (MIGLYOL 812 Caprylic/ Capric Triglyceride) or equivalent) | qs | qs | Carrier |
| Lecithin Liquid | 1.63 | 0.25 | Lubricant/ Emulsifier |
| Butylated Hydroxytoluene (also referred to as "BHT") | 0.13 | 0.02 | Antioxidant |

The above formulation is prepared as follows: MIGLYOL (caprylic/capric triglyceride) MIGLYOL is heated to about 45° C. GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) is added and mixed until dissolved. BHT is added and mixed until dissolved. Progesterone is suspended and passed through a colloid mill. The resultant fill mass can be used for encapsulation.

In an exemplary embodiment, a capsule is provided containing a fill material having partially solubilized progesterone comprising:

17

TABLE 13

| Ingredient | Qty/ Capsule (mg) | % w/w | Qty/ Capsule (mg) | Amount/ Batch (kg) |
|---|-------------------------|-------|--------------------------|--------------------------|
| Micronized Progesterone, USP | 200.00 | 33.33 | Active | 2.0 |
| Monoglycerides/ diglycerides/triglycerides of caprylic/capric acid (CAPMUL MCM) (Medium Chain Mono- and Diglycerides) | 394.0 | 65.67 | Carrier | 3.94 |
| Lauroyl polyoxyl-32 glycerides (GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) or equivalent) | 6.0 | 1 | Lubricant/ Emulsifier | 0.06 |
| Total | 600.00 mg | 100 | | 6.0 kg |

For suspensions of progesterone and partially solubilized progesterone, GELUCIRE 44/14 may be added at 1% to 2% w/w to increase viscosity. The above formulation is prepared as follows: CAPMUL MCM (Medium Chain Mono- and Diglycerides) is heated to about 65° C. GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) is added and mixed until dissolved. Heat is removed. Proges-

Example 9

In an exemplary embodiment, a capsule is provided containing a fill material having suspended progesterone comprising:

TABLE 14

| Ingredient | % | mg/ Capsule | Function |
|---|-------|----------------|---------------------|
| Micronized Progesterone | 30.77 | 200.00 | Active |
| Medium Chain Triglyceride MIGLYOL 812 (Caprylic/ Capric Triglyceride) or equivalent) | 65.93 | 428.55 | Carrier |
| Lauroyl polyoxyl-32 glycerides (GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) or equivalent) | 300 | 19.50 | Suspending Agent |
| Butylated Hydroxytoluene | 0.03 | 1.95 | Antioxidant |
| Total | 100 | 650 | |

In various embodiments, amounts of MIGLYOL (caprylic/capric triglyceride) may be present in a range from about 35-95% by weight; GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) from about 0.5-30% by weight; and BHT from about 0.01-0.1% by weight.

Example 10

For the purposes of this Example, a particle size analysis is conducted by using the Beckman Device. A sample API com-

18

prising micronized progesterone in accordance with various embodiments is provided for analysis.

Approximately 0.01 g of a sample API in accordance with various embodiments was combined with Coulter 1B and 10 mL of deionized water. Sonication was performed for 15 seconds. The Beckman Device, equipped with a ULM, performed analysis for 90 seconds. The Beckman Device was configured to use the Fraunhofer optical model. The Beckman Device yielded that the sample has an X50 of 4.279 μ m, an X75 of 7.442 μ m, and an X25 of 1.590 μ m. The Beckman Device also yielded that the mean particle size is 4.975 μ m, the median particle size is 4.279 μ m, the mode particle size is 6.453 μ m, and the standard deviation is 3.956 μ m. A graph of the particle distribution obtained is shown in FIG. 4.

Example 11

A formulation sample having approximately 200 mg of micronized progesterone and 2 mg of estradiol was dispersed with oil. The Beckman Device, equipped with a MLM, performed analysis for 60 seconds. The Beckman Device was configured to use the Fraunhofer optical model. The Beckman Device yielded that the sample has an X50 of 11.0 μ m, an X75 of 17.3 μ m, and an X25 of 5.3 μ m. The Beckman Device also yielded that the mean particle size is 11.8 μ m, the median particle size is 11.04 μ m, the mode particle size is 13.6 μ m, and the standard deviation is 7.8 μ m.

Example 12

In order to increase the solubility of progesterone in the final solution, GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) was added at about 10% w/w.

TABLE 15

| Quantitative Formula: Batch Size 10,000 capsules | | | | | |
|--|--|------------------|--------|----------------------|-----------------------|
| Item No. | Ingredient(s) | Label Claim (mg) | % w/w | Qty/ Capsule (mg) | Amount/ Batch (kg) |
| 1. | Progesterone, USP, micronized | 50.00 | 7.14 | 50.00 | 0.50 |
| 2. | Estradiol Hemihydrate, USP | 2.03 | 0.29 | 2.03 | 0.02 |
| 3. | CAPMUL MCM (Medium Chain Mono- and Diglycerides), NF | | 82.57 | 577.97 | 5.78 |
| 4. | GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) Gelucire 44/14, NF | | 10.0 | 70.00 | 0.70 |
| Total: | | | 100.00 | 700.00 | 7.00 |

An example of the final formulation is provided in Table 15. The manufacturing process is as follows. CAPMUL MCM (Medium Chain Mono- and Diglycerides) is heated to 40° C. GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) is added and mixed until dissolved. Heat is removed. Estradiol is added and mixed until dissolved. Micronized progesterone is then added and mixed until dissolved.

19

Example 13

In an exemplary embodiment, a capsule is provided containing a fill material having fully solubilized estradiol and partially solubilized progesterone comprising:

TABLE 16

| Item No. | Ingredient(s) | Label Claim (mg) | % w/w | Qty/ Capsule (mg) | Amount/ Batch (g) |
|----------|---|------------------|---------|-------------------|-------------------|
| 1. | Progesterone, USP, micronized | 50.00 | 25.000 | 50.00 | 500.00 |
| 2. | Estradiol Hemihydrate | 0.25 | 0.129 | 0.26 | 2.58 |
| 3. | CAPMUL MCM (Medium Chain Mono- and Diglycerides), NF | | 73.371 | 146.74 | 1467.42 |
| 4. | GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)), NF | | 1.500 | 3.00 | 30.00 |
| Total: | | | 100.000 | 200.00 mg | 2000.00 |

The manufacturing process is as follows. CAPMUL MCM (Medium Chain Mono- and Diglycerides) is heated to 65° C. GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)) is added and mixed until dissolved. Heat is removed. Estradiol is added and mixed until dissolved. Micronized progesterone is then added and dispersed. The mixture is then passed through a colloid mill. The resultant fill mass can be used for encapsulation.

Example 14

In an exemplary embodiment, a capsule is provided containing a fill material having fully solubilized estradiol and partially solubilized progesterone comprising:

TABLE 17

| Item No. | Ingredient(s) | Label Claim (mg) | % w/w | Qty/ Capsule (mg) | Amount/ Batch (g) |
|----------|---|------------------|--------|-------------------|-------------------|
| 1. | Progesterone, USP, micronized | 200.00 | 33.33 | 200.0 | 2000.0 |
| 2. | Estradiol Hemihydrate | 2.00 | 0.35 | 2.07 | 20.7 |
| 3. | CAPMUL MCM (Medium Chain Mono- and Diglycerides), NF | | 65.32 | 391.93 | 3919.3 |
| 4. | GELUCIRE 44/14 (Lauroyl macrogol-32 glycerides EP Lauroyl polyoxyl-32 glycerides NF Lauroyl polyoxylglycerides (USA FDA IIG)), NF | | 1.00 | 6.0 | 60.0 |
| Total: | | | 100.00 | 600.0 mg | 6000.0 |

The manufacturing process is as follows. CAPMUL MCM (Medium Chain Mono- and Diglycerides) is heated to 65° C. Gelucire 44/14 is added and mixed until dissolved. Heat is removed. Estradiol is added and mixed until dissolved. Micronized progesterone is then added and dispersed. The mixture is then passed through a colloid mill. The resultant fill mass can be used for encapsulation.

20

Example 15

Progesterone and Estradiol Combination Study Under Fed Conditions

This following study protocol was used to establish bio-availability and bio-equivalence parameters for a combination product of the present disclosure comprising progesterone (200 mg) and estradiol (2.0 mg) as prepared via the process described in Example 14 and compared to 200 mg of PROMETRIUM (progesterone, USP) (Catalent Pharmaceuticals, St. Petersburg, Fla. (and 2.0 mg of ESTRACE (estradiol vaginal cream, USP, 0.01%) (Bristol-Myers Squibb Co. Princeton, N.J.), administered to twenty-four (24) normal healthy, adult human post-menopausal female subjects under fed conditions.

The Study Design: An open-label, balanced, randomized, two-treatment, two-period, two-sequence, single-dose, two-way crossover.

The subjects were housed in the clinical facility from at least 11.00 hours pre-dose to at least 48.00 hours post-dose in each period, with a washout period of at least 14 days between the successive dosing days.

Subjects were fasted for at least about 10.00 hours before being served a high-fat, high-calorie breakfast, followed by dosing, then followed by a 04.00 hour, post-dose additional period of fasting.

Standard meals were provided at about 04.00, 09.00, 13.00, 25.00, 29.00, 34.00 and 38.00 hours post-dose, respectively.

Water was restricted at least about 01 hour prior to dosing until about 01 hour post-dose (except for water given during dosing). At other times, drinking water was provided ad libitum.

Subjects were instructed to abstain from consuming caffeine and/or xanthine containing products (i.e. coffee, tea, chocolate, and caffeine-containing sodas, colas, etc.) for at least about 24.00 hours prior to dosing and throughout the study, grapefruit and/or its juice and poppy containing foods for at least about 48.00 hours prior to dosing and throughout the study.

Subjects remained seated upright for about the first 04.00 hours post-dose and only necessary movements were allowed during this period. Thereafter subjects were allowed to ambulate freely during the remaining part of the study. Subjects were not allowed to lie down (except as directed by the physician secondary to adverse events) during restriction period.

Subjects were instructed not to take any prescription medications within 14 days prior to study check in and throughout the study. Subjects were instructed not to take any over the counter medicinal products, herbal medications, etc. within 7 days prior to study check-in and throughout the study.

After overnight fasting of at least about 10.00 hours, a high-fat high-calorie breakfast was served about 30 minutes prior to administration of investigational product(s). All subjects were required to consume their entire breakfast within about 30 minutes of it being served, a single dose of either test product (T) of Progesterone 200 mg & Estradiol 2 mg tablets or the reference product (R) PROMETRIUM (progesterone, USP) soft gel Capsule 200 mg and ESTRACE (estradiol vaginal cream, USP, 0.01%) ESTRACE® (Estradiol) Tablets 2 mg (according to the randomization schedule) were administered with about 240 mL of water under fed condition, at ambient temperature in each period in sitting posture. A thorough mouth check was done to assess the compliance to dosing.

21

All dosed study subjects were assessed for laboratory tests at the end of the study or as applicable.

In each period, twenty-three (23) blood samples were collected. The pre-dose (10 mL) blood samples at -01.00, -00.50, 00.00 hours and the post-dose blood samples (08 mL each) were collected at 00.25, 00.50, 00.67, 00.83, 01.00, 01.33, 01.67, 02.00, 02.50, 03.00, 04.00, 05.00, 06.00, 07.00, 08.00, 10.00, 12.00, 18.00, 24.00 and 48.00 hours in labeled K2EDTA—vacutainers via an indwelling cannula placed in one of the forearm veins of the subjects. Each intravenous indwelling cannula was kept in situ as long as possible by injecting about 0.5 mL of 10 IU/mL of heparin in normal saline solution to maintain the cannula for collection of the post-dose samples. In such cases blood samples were collected after discarding the first 0.5 mL of heparin containing blood. Each cannula was removed after the 24.00 hour sample was drawn or earlier or if blocked.

At the end of the study, the samples were transferred to the bio-analytical facility in a box containing sufficient dry ice to maintain the integrity of the samples. These samples were stored at a temperature of $-70^{\circ}\text{C} \pm 20^{\circ}\text{C}$ in the bio-analytical facility until analysis.

Progesterone (Corrected and Uncorrected) and Estradiol (unconjugated) and estrone (total) in plasma samples is assayed using a validated LC-MS/MS method.

Fasted studies using this protocol were also conducted. However, rather than the high-fat meal prior to administration of the test and reference drug, each subject fasted for a period of at least twelve (12) hours prior to dose administration.

Example 16

Method of manufacture in accordance with various embodiments are shown in FIGS. 1-3. With reference to FIG. 1, method of fill material 100 is shown. Step 102 comprises heating an oily vehicle carrier to $40^{\circ}\text{C} \pm 5^{\circ}\text{C}$. Heating may be accomplished through any suitable means. The heating may be performed in any suitable vessel, such as a stainless steel vessel. The oily vehicle may be any oily vehicle described herein, for example, CAPMUL MCM (Medium Chain Mono- and Diglycerides).

Step 104 comprises mixing Gelucire 44/14 with the oily vehicle. Mixing may be facilitated by an impellor, agitator, or other suitable means. Step 102 may be performed under an inert or relatively inert gas atmosphere, such as nitrogen gas N_2 . Mixing may be performed in any suitable vessel, such as a stainless steel vessel.

Step 106 comprises mixing estradiol into the mixture of the oily vehicle and Gelucire 44/14. Mixing may occur in a steel tank or vat. Mixing may be facilitated by an impellor, agitator, or other suitable means. Step 106 may be performed under an inert or relatively inert gas atmosphere, such as nitrogen gas N_2 .

Step 108 comprises cooling to room temperature. Cooling may be allowed to occur without intervention or cooling may be aided by application of a cooling system.

Step 110 comprises mixing micronized progesterone into the mixture of oily vehicle, estradiol and Gelucire 44/14. Mixing may occur in a steel tank or vat. Mixing may be facilitated by an impellor, agitator, or other suitable means. Step 110 may be performed under an inert or relatively inert gas atmosphere, such as nitrogen gas N_2 . Step 112 comprises degassing. The resulting mixture from step 112 may comprise a fill material suitable for production into a softgel capsule.

With reference to FIG. 2, softgel capsule, i.e. gel mass, production 200 is shown. Step 202 comprises mixing glycerin with water. The water used in step 202 may be purified by any

22

suitable means, such as reverse osmosis, ozonation, filtration (e.g., through a carbon column) or the like. Mixing may be facilitated by an impellor, agitator, or other suitable means. Step 202 may be performed under an inert or relatively inert gas atmosphere, such as nitrogen gas N_2 . Heating may be performed until the temperature reaches $80^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

Step 204 comprises the addition of gelatin to the glycerin water mixture. Mixing may be facilitated by an impellor, agitator, or other suitable means. Step 204 may be performed under an inert or relatively inert gas atmosphere, such as nitrogen gas N_2 . A vacuum may be drawn in step 204 to de-aerate.

Step 206 comprises addition of a coloring agent such as a dye. A coloring agent may comprise products sold under the trademark OPATINT or other suitable agent. Step 206 may be performed under an inert or relatively inert gas atmosphere, such as nitrogen gas N_2 . Step 208 comprises degassing. The resulting mixture from step 208 may comprise a gel capsule material suitable for use as a gel capsule in production of a softgel capsule.

With reference to FIG. 3, softgel capsule assembly process 300 is shown. Step 302 comprises heating the fill material. The fill material may be heated to any suitable temperature. In various embodiments, the fill material is heated to $30^{\circ}\text{C} \pm 3^{\circ}\text{C}$. Fill material may be heated in a fill hopper. A fill hopper may comprise a device configured to hold a volume of the fill material and/or to dispense the fill material in controlled volumes. Step 304 comprises filling a gel mass. A gel mass may be taken from the gel capsule material produced in step 208 of FIG. 2. Filling may be performed by injecting, placing, or otherwise disposing the fill material within a volume defined by the gel capsule material. The filling may occur in an encapsulator. The spreader boxes may be a temperature of $55^{\circ}\text{C} \pm 10^{\circ}\text{C}$. The wedge temperature may be $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$. The drum cooling temperature may be $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The encapsulator may be lubricated using MIGLYOL 812 (Caprylic/Capric Triglyceride) or other suitable lubricant. Step 304 thus produces one or more softgel capsules. Filling may comprise producing a ribbon of thickness $0.85\text{ mm} \pm 0.05\text{ mm}$ using spreader box knobs. The fill material may be injected into the gel to produce a fill weight having target weight $\pm 5\%$ (i.e., $650 \pm 33\text{ mg}$ and $325 \pm 16.3\text{ mg}$).

Step 306 comprises drying the softgel capsules. Drying may be performed in a tumble dryer, tray dryer, or combinations thereof. For example, drying may be performed in a tumble drying basket for between about 10 minutes and about 120 minutes. Drying may continue in a drying room for about 24 hours to about 72 hours. Step 308 may comprise inspection and/or polishing. Polishing may be performed with isopropyl alcohol. Step 310 may comprise packaging. Packaging may be accomplished through any suitable means. Packaging may comprise packing softgel capsules into a blister pack, bottle, box, pouch, or other acceptable packaging.

We claim:

1. A pharmaceutical formulation comprising solubilized estradiol, suspended progesterone, and a medium chain solubilizing agent;

wherein each of the estradiol and the suspended progesterone are present in the solubilizing agent and the estradiol and the suspended progesterone are uniformly dispersed;

wherein at least about 90% of the estradiol is solubilized in the solubilizing agent; and

wherein the solubilizing agent comprises a C6-C12 oil.

2. The pharmaceutical formulation of claim 1, further comprising partially solubilized progesterone.

3. The pharmaceutical formulation of claim 1, wherein the formulation is contained within a gelatin capsule.

4. The pharmaceutical formulation of claim 1, wherein the medium chain solubilizing agent is selected from at least one of mono-, di-, and triglycerides and combinations thereof. 5

5. The pharmaceutical formulation of claim 1, wherein said estrogen has a dosage strength at least about 0.125 mg and wherein said progesterone has a dosage strength at least about 25 mg.

6. The pharmaceutical formulation of claim 1, wherein the 10
ratio of progesterone to estradiol is at least 95:1.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8,633,178 B2
APPLICATION NO. : 13/684002
DATED : January 21, 2014
INVENTOR(S) : Brian A. Bernick et al.

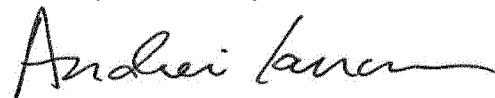
Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

At item (72), please add inventor --Frederick D. Sancilio, Palm Beach Gardens, FL (US)--

Signed and Sealed this
Twenty-sixth Day of March, 2019

A handwritten signature in black ink, appearing to read "Andrei Iancu".

Andrei Iancu
Director of the United States Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8,633,178 B2
APPLICATION NO. : 13/684002
DATED : January 21, 2014
INVENTOR(S) : Brian A. Bernick et al.

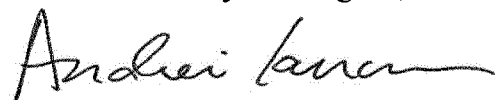
Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Column 23, Claim 5, Line 7: Delete “estrogen” and insert in its place --estradiol--.

Signed and Sealed this
Twentieth Day of August, 2019



Andrei Iancu
Director of the United States Patent and Trademark Office